F-15 EAGLE ENGAGED

THE WORLD'S MOST SUCCESSFUL JET FIGHTER

STEVE DAVIES
DOUG DILDY

F-15 Eagle Engaged superbly captures the "true personality" of the F-15 by not only detailing the four decades of technologies that have given it unmatched combat performance, but also letting you meet the men and women who designed, flew, and maintained this magnificent jet, allowing it to be called "The World's Most Successful Jet Fighter."

**BRIGADIER GENERAL (RET.) DICK "LIPS" BANHOLZER,
DIRECTOR, BUSINESS DEVELOPMENT,
USAF FIGHTERS AND WEAPONS, THE BOEING COMPANY**

OSPREY
PUBLISHING
www.ospreypublishing.com

UK £25.00
ISBN 978-1-84603-169-4
9 781846 031694

F-15 EAGLE ENGAGED

THE WORLD'S MOST SUCCESSFUL JET FIGHTER

The F-15 Eagle is undoubtedly the most successful jet fighter of all time: with a kill ratio that exceeds 105: 0, the Eagle has never lost an air-to-air dogfight.

Flown not only by the US Air Force but by the air forces of Israel, Saudi Arabia and Japan, and with over 30 years of service, the F-15 is the world's foremost operational air superiority and intercept warplane.

In this book, the authors draw on a vast array of sources including combat records, technical documents, and unpublished first-hand accounts from the pilots themselves to tell the story of this amazing plane. Comprising detailed technical information alongside fascinating combat stories and accounts, this is the definitive history and guide to the world's most successful jet fighter.

STEVE DAVIES has written five books on the F-15. He is a full-time freelance aviation photojournalist, and is widely recognized as a leading expert on modern military aviation matters. He writes for leading aviation monthly magazines. In addition to his writing, Steve works as an advisor for a number of television production companies, and he has also appeared in a series of documentaries. Steve has been working for a major part-work publishing house for over two years, during which time he has filmed interviews, written scripts, and created a series of 52 combined part-work/DVD products.

DOUG DILDY is a retired US Air Force (USAF) colonel who spent nine years of his 26-year career in Western Europe and retired with 3,200 hours flying fast jets, almost half of that as an F-15 Eagle pilot.
As commander of the 32d Fighter Squadron, Soesterberg AB, NL, he enforced the No-Fly Zone over Iraq, acquiring over 100 hours of combat time in the F-15. Doug is a USAF Academy graduate with a degree in history. He attended the US Armed Forces Staff College and USAF Air War College and has a Master's Degree in Political Science. A student of modern European military history, he has written several campaign studies. He has also authored a number of articles for notable US aviation history magazines and is a regular contributor to the amateur modelling magazine *Small Air Forces Observer*. In his spare time he continues to fly McDonnell Douglas/Boeing planes, including the DC-10 for a major cargo airline.

F-15 EAGLE ENGAGED

STEVE DAVIES
DOUG DILDY

OSPREY

EG

F-15 EAGLE ENGAGED

THE WORLD'S MOST SUCCESSFUL JET FIGHTER

OSPREY
PUBLISHING

This book is dedicated to Capt Jeff "Wedge" Roether and Capt Rich "Hub" Kendel,
two of the 32 USAF pilots who gave their lives in the defense of their nation
while operating the F-15 Eagle.

F-15 EAGLE ENGAGED

THE WORLD'S MOST SUCCESSFUL JET FIGHTER

STEVE DAVIES ▪ DOUG DILDY

First published in Great Britain in 2007 by Osprey Publishing
Midland House, West Way, Botley, Oxford OX2 0PH, United Kingdom.
443 Park Avenue South, New York, NY 10016, USA.
Email: info@ospreypublishing.com

© 2007 Osprey Publishing Ltd

All rights reserved. Apart from any fair dealing for the purpose of private study, research, criticism or review, as permitted under the Copyright, Designs and Patents Act, 1988, no part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, electrical, chemical, mechanical, optical, photocopying, recording or otherwise, without the prior written permission of the copyright owner. Enquiries should be addressed to the Publisher.

Every attempt has been made by the Publisher to secure the appropriate permissions for materials reproduced in this book. If there has been any oversight we will be happy to rectify the situation and a written submission should be made to the Publisher.

A CIP catalog record for this book is available from the British Library

ISBN 978 1 84603 169 4

Index by Alan Thatcher
Typeset in ITC Stone Serif, Sabon, Gill Sans, New Baskerville and Univers
Originated by PDQ Media, Bungay, UK
Printed and bound in China through Bookbuilders

07 08 09 10 11 10 9 8 7 6 5 4 3 2 1

For a catalog of all books published by Osprey please contact:

NORTH AMERICA
Osprey Direct c/o Random House Distribution Center
400 Hahn Road, Westminster, MD 21157, USA
E-mail: info@ospreydirect.com

ALL OTHER REGIONS
Osprey Direct UK, P.O. Box 140, Wellingborough, Northants, NN8 2FA, UK
E-mail: info@ospreydirect.co.uk

www.ospreypublishing.com

Front cover and p.287 and 288 images © Steve Davies: www.fjphotography.com
Endpaper image © Tyson V. Rininger: www.tvrphotography.com

CONTENTS

ACKNOWLEDGMENTS 2
FOREWORD BY LTCOL MIKE "DOZER" SHOWER 4
01 THE F-X COMPETITION 6
02 THE MCDONNELL DOUGLAS 199-B DESIGN 22
03 TEST & EVALUATION 36
04 F-15 SERVICE ENTRY 52
05 HAPPINESS IS... GEASLES AND A SWEATY G-SUIT 72
06 ACTIVE DUTY EAGLE UNITS IN THE COLD WAR 92
07 DEFENDING THE HOMELAND: AIR DEFENSE AND ALASKAN EAGLES 118
08 AIR NATIONAL GUARD EAGLES 130
09 FOREIGN MILITARY SALES EAGLES 142
10 IMPROVED EAGLES 158
11 WHEN EAGLES FLY, MIGS DIE! 170
12 BURNING DEAD DINOSAURS: ENFORCING THE NO-FLY ZONES OVER IRAQ 202
13 BALKAN KILLS 214
14 THE EAGLE'S FUTURE 228
APPENDICES 236
ABBREVIATIONS & ACRONYMS 263
ENDNOTES 266
INDEX 277

ACKNOWLEDGMENTS

STEVE DAVIES

There are few fighters that capture my imagination in the same way that the Eagle does, and while I have written a lot about the F-15 and have oodles of enthusiasm for it, nothing prepared me for the long journey that this book would take me on. The changing tones of Doug "Disco" Dildy's e-mail signatures as every day we were consumed more and more by this book said it all: they started with the Churchill quote, "Writing a book is an adventure. It begins as an amusement, then it becomes a mistress, then a master, and finally, a tyrant"; then changed to the Hemingway quote, "Actually, I hate writing. But I love being published"; before finally becoming the self-quote, "There's nothing wrong with this book that six more weeks of work can't fix!"

All joking aside, I hope that you enjoy reading this book – there's something in it for everyone, whether you're an enthusiast, historian, engineer, aviator or simply curious. I believe that the most significant aspect to this book is that it has been co-authored by an Eagle Driver of some experience. Disco's input will let you see further inside the Eagle community, better understand the inner thinking of an F-15 pilot, and more readily grasp the importance of the Eagle than any text I could have written; I thank him for giving this book an integrity that you will find in few others. Thanks are also due to Anita Baker at Osprey, for it was her belief in this book that took it from a synopsis to a reality. Several F-15 units provided assistance to me as I zipped around the US researching and interviewing, but none more so than the great men and women of the 33rd FW at Eglin, the 48th FW at RAF Lakenheath, and the Missouri ANG's 131st FW at St. Louis. Col Moss "MOS" Mohr, Capt Brent "Stagger" Bak, Capt Kristy Beckman, Capt Beth Horine, Lt Aaron Henninger, Sgt Michelle Motz and Jenna McMullin deserve special mention for their help. Boeing also deserves thanks, as once again it pulled out all the stops to make things happen, and I owe much to its encyclopedic historian, Larry Merritt. Paul "Two Drones" Eden, freelance aerospace editor extraordinaire, took our rough 'n' ready manuscript and carefully extracted and corrected the inconsistencies and errors with his usual good humored style – I want to extend my thanks to him for taking the project on and seeing it through to completion, no less! Finally, I want to thank Caroline, my long-suffering partner, for not complaining when I spent hours in the study consumed by the book, and for putting up with the sleep deprivation that resulted from my many late night telephone conversations with Disco – she and I both knew that Disco's "10-percent true" fighter pilot stories couldn't go on forever, but God knows that some nights he tried! With any work of this size there are bound to be small errors that creep in, for these I apologize in advance (or simply blame Disco, depending upon how unforgivable the error is). I can be contacted via www.eagleengaged.com.

THE AUTHORS WOULD ALSO LIKE TO THANK:

BrigGen (Ret) Dick "Lips" Banholzer, George Graff, Capt Brooke Brander, Mary Ann Brett, Paul Homsher, Chris Haddox, Richard Noyes, Irv Burrows, Maj (Ret) Craig "Quizmo" Brown, TSgt Kathleen Cordner, Col (Ret) C. R. "Dick" Anderegg, Col (Ret) Marshall L. Michel III, aviation historians Robert F. Dorr and Warren Thompson, F-105 historian W. Howard Plunkett, BGen (Ret) Mark "Magic" Beesley, LtCol Michael "Dozer" Shower, Col Anthony "ET" Murphy, Col Larry "Cherry" Pitts, LtCol Tony "Kimo" Schiavi, LtCol Tim "Sweet Lou" Kline,

DOUG DILDY

There are vast numbers of books about specific airplane types and several very good ones about the F-15 itself. But no book about airplanes is truly a complete story unless it also features the men (and now women) who flew them. Without pilots, single-seat fighters are just "iron on the ramp" – or in the case of the only fighter I ever flew, increasingly becoming exhibits in museums or stuck on a pole outside the main gate of a station. So my goal in this tome was to make it as much about the men who flew the jet as it was about the jet itself. I am proud to have served my country flying the F-15 Eagle with every one of the men named in this book. We fighter pilots are banded together into small units called "squadrons" and these too have a life cycle of their own – a birth, a heritage, an exciting life, and ultimately, a death. Squadrons are the context into which the men and the machines are fitted to do their job – in this case to gain and maintain air superiority so that all other missions, both airborne and on the surface, can be enabled and protected. So the squadron, that band of Eagle Drivers who live, work, fly and fight together, features in this work almost as much as the individual men and the technical details of the machine. Hopefully this depth of detail will provide the framework and background that puts the actions of the men at the controls of this most awesome air-to-air fighter of the 20th century into the proper context. Finally, I have to agree with Steve: I spent countless hours editing his work and correcting his errors. One or two may have slipped through, for which I apologize. But to Steve Davies, I owe a great debt of gratitude for launching this project and inviting me to join in, and for putting up with my many redirects and alterations as we strove for accuracy – a difficult task as the history of the Eagle is an expansive story rife with myths and misinformation. Steve is an expert on the technical aspects of the F-15 and I must admit I learned more about the jet that I flew by researching it with Steve than I ever knew as a pilot flying it! Also I would like to express my thanks to Paul Eden, our editor, who made this fighter pilot's ramblings make sense and who made the editorial process a joy to participate in – this book is tremendously better for his efforts. Finally, but most important, I thank my wife Ann who encouraged me to participate in this work and gallantly put up with my absences (sometimes mentally even though I was present physically) to complete it. Being an Air Force spouse for 24 years was hard enough, but to put up with that again in "retirement" was a burden no wife should have to bear. To her go my great admiration, my deep gratitude, and all my love. Lastly, (since I've already used "finally"), as a self-respecting former fighter pilot, I guarantee that everything written in this book is at least 10 percent true! Contact me via www.eagleengaged.com.

LtCol Matt "Boz" Beals, LtCol Bill "Turf" Murphy, LtCol Steve "Daihatsu" Dastuta, LtCol Mike "Father" Flanagan, LtCol Joe "Corn" Hruska, LtCol Brian "Spiderman" Kamp, Rick "Kluso" Tollini, Crag Luther, LtCol John "Clam" McNeil, Maj Justin "Ringo" Fletcher, LtCol (Ret) Gary "Reverend" Klett, Capt Greg "Lava" Moulton, Capt Jason "Digger" Zumwalt, FedEX Capt Gary "Yoda" Byrd, Nir Ben-Yosaf, Rob Tabor, Tyson V. Rininger, Erik Sleutelberg, Andreas Zeilter, Skip Prestridge, LtCol Mike "Boa" Straight, Bob Whetton of www.graphic-artwork.co.uk, and Stefan Goossens, Jurgen van Toor and the Dutch Aviation Society's ("Scramble") excellent F-15 database.

FOREWORD

BY LTCOL MICHAEL "DOZER" SHOWER

F-22A RAPTOR SQUADRON COMMANDER
AND F-15 MIG KILLER

Steve and Doug have given me a unique opportunity, the chance to write about their book and the mighty F-15 Eagle. I'll try to fulfill their request to go full circle from the F-15 to the F-22; it's a risky proposition since fighter pilots aren't known for their prose. I am a very lucky pilot (in more ways than I have time to write about), mostly because I had the great fortune to fly the F-15, in peace and war. Membership of the Eagle pilot club is not big in relative terms. In fact, more people have played professional football over the years than have flown F-15s. One certainly has to work hard, be a decent pilot, and have a little luck to get a chance to strap into an Eagle. Luck I hear you say? Any honest pilot will tell you luck and timing always play a part. You just hope your luck and timing last longer than your flying career. Some pilots only flew an assignment or two in the Eagle and others were lucky to fly it their entire career. I would have been one of those lucky few until my life took a twist into the world of the F-22. (I still consider myself to be extremely lucky with unconscious timing though.)

I believe the Eagle may well end up in history as the most feared and respected fighter of all time – and why not? What other aircraft has an air-to-air combat ratio of 104 to 0? What other aircraft dominated the skies for over 30 years (and still counting), and never lost its reputation? There have certainly been other great aircraft, so why does the Eagle seem to be in a class by itself? Is it just a lucky jet? This is hardly the case. In fact, there are many very tangible reasons which explain the phenomenon of the Eagle legend. First, the Eagle has an incredible design: fast, powerful, maneuverable, with long range to top it off. Its avionics were, and with various upgrades continue to be, state of the art and revolutionary. Combined with the introduction of HOTAS, a user friendly HUD, and cockpit ergonometrics, the F-15 enabled pilots to do things they simply couldn't before. The Eagle is an absolute joy to fly, easy and forgiving, a fact which doesn't change even when flying it aggressively; it's almost as if the jet knows when to be calm and when to rage. To me it almost feels as if the jet somewhat comes alive once you're in it.

The design and layout were meant to enable one pilot to efficiently hunt and kill other airplanes, and was it ever successful! Not long after its initial operational debut, and in the hands of the Israelis very early on, the F-15 climbed to the top of the hill not just in training, but in actual combat. You can almost hear the jet daring anyone to knock it off the top of the heap. As the combat record attests, many have tried and all have failed. However, you can't tout the jet in a vacuum. Without pilots and maintainers it's just a hunk of metal – a beautiful hunk of metal – but a hunk nonetheless. Pilots are the soul of the Eagle once the JFS handle is pulled and until the motors are shut down.

There has never been a shortage of incredibly intelligent, hard working, and dedicated F-15 pilots. In fact, many Eagle pilots have become icons in the various air forces which employ it. Over the years their efforts to establish a solid building block approach to training in, and employing, the Eagle have helped make it such a success. The Eagle community became known for its rigid adherence to high briefing and debriefing standards. This focused Eagle Drivers on getting the most out of each invaluable sortie. Of course, it helps when you have one primary mission (air combat); it's easier to be a master of one thing than a jack of all trades. Any mention of how great the Eagle is (or its pilots!) fails miserably to convey the full story unless it mentions those who toiled in the heat, cold, rain and snow, day or night around the globe, to keep F-15s in the air.

Without the thousands who supported it, from turning wrenches to loading weapons to driving fuel trucks, pilots would have never left the ground to achieve such a phenomenal record. Don't think a crew chief isn't as finicky, or in love with his jet, as any pilot ever was. Every Eagle pilot who ever took to the air owes their gratitude, and in fact their life, to those who keep Eagles flying.

So where does that leave us today? The sun surely hasn't set on the F-15 by a long shot. The world's "Greatest Air Superiority Fighter" has a lot of fight left in it. Through upgrades it'll remain viable and deadly well into the 21st century, fighting right alongside the new kid on the block, the F-22 Raptor. As the next generation F-22 continues to cut its teeth and grow its own "urban legend," in some ways it may always be overshadowed by its older big brother, as such an incredible combat record will be hard to beat. Having had the unique luck to fly both amazing aircraft, I'll never forget where my roots are. I don't see how anyone who has flown the F-15 ever could. Of course, if any fighter can hope to be worthy of such a record as the Eagle's, the F-22 is certainly it. It's a monumental leap forward with its stealth and supercruise, two features we'd never be able to achieve with an F-15. Combined with its integrated avionics and situational awareness it's a truly revolutionary aircraft in the realm of air-to-air combat (and it's no slouch in a dogfight with its super maneuverability and thrust vectoring either). There is significant proliferation around the globe of modern integrated air defense systems (surface-to-air missiles and advanced fighter aircraft). The F-22 ensures, for many decades to come, our ability to operate freely and protect our forces from enemy attack, even in places where our older fighters can't go – one of its true advantages.

In a final irony the F-15 and F-22 aren't competing against each other as you might expect. Instead, we've discovered the F-15 and F-22 work much better together as a team. Both bring synergistic effects to the battlefield which makes us more lethal working together than we could be working separately. Expect to see F-15s in the battle for many years to come – their work isn't over!

The mighty Eagle brought many revolutionary aspects to air combat when it was introduced. It set a record unmatched in the history of air warfare. It has deservedly become a legendary airplane. To those who paved the way we are indebted to your efforts and awed by your achievements. To those who, even as I write this, continue to preserve and fight for freedom flying, maintaining and supporting the Eagle, we say with all sincerity thank you! And to those still to come, who will inherit the legacy of the Eagle, you have big shoes to fill. I have no doubt that you'll live up to every aspect of the challenge. After all, you're about to fall in love with one of the best aircraft the world has ever known!

SN081

01

THE F-X COMPETITION

LESSONS IN HISTORY

On June 25, 1950 South Korea was invaded by communist North Korea. The recently created United Nations (UN) established a force in response, which comprised assets from a number of nations, including Great Britain, Canada and Australia, and, led by US forces, it spent the next three years driving back North Korean forces and restoring the status quo.

From a military aviation perspective the Korean War marked the first true encounter between American jet fighters and those built by the Union of Soviet Socialist Republics (USSR). Using the fast, maneuverable and powerfully armed North American F-86 Sabre against the Mikoyan-Gurevich (MiG) design bureau's much touted and far more numerous MiG-15, the US Air Force's (USAF's) kill ratio at the end of the conflict stood at 7:1. The MiG-15 (NATO/ASCC [North Atlantic Treaty Organization/Air Standards Coordinating Committee] codename "Fagot") was the latest Soviet jet fighter and established the mold for the country's future fighter designs: it was simple, rugged, maneuverable, straightforward to operate and easy to replace. Moscow had provided examples of the "Fagot" to North Korea and China – and even supplied seasoned fighter pilots/instructors – during the conflict to help even the balance between its communist allies in the north and the capitalist UN forces to the south.

Memories from World War II were still fresh in the minds of many US pilots. Taking the F-86 into combat was simply an extension of what they had been doing only five years before in Europe and the Pacific, flying P-51 Mustangs, P-47 Thunderbolts and P-38 Lightnings against Messerschmitts, Focke-Wulfs and Zeros. The kill ratios that these men recorded in the skies over Korea came because they were intimately versed in the art of aerial maneuver and combat, because they were largely free to pick and choose the battles they fought and the terms on which they did so, and because their Sabres were fast, maneuverable and armed with simple and reliable weaponry that had not changed greatly since the beginnings of air combat in 1915. They could not possibly have known that by the time the US next engaged in sustained combat operations, all of this would have changed.

However, change it did. Following the Korean War, US and Soviet fighter designers took increasingly divergent paths in developing their products. In fact, US fighter designers embarked upon two distinctly different, though seemingly complementary, tracks as well – designing aircraft to either defend against or deliver nuclear weapons. During the final half of the 1950s Strategic Air Command (SAC) ruled the USAF[1] and it decreed that any fighter would be justifiable only if it delivered atom bombs or defended against any attack using them. Consequently, the Century-series fighters (F-100 through F-106) evolved along either of these two tracks, culminating

OPPOSITE
The slatted F-4E gave the Phantom II a boost in low-speed performance and made it more capable in the dogfight. With its built in M61A1 gun below the nose, it was a much better air-to-air platform than previous F-4 variants. (USAF)

in the Convair F-106 as the ultimate air defense interceptor, and the Republic F-105 as the primary nuclear-delivery tactical fighter.

When the Kennedy Administration brought Robert S. McNamara to the head of the Department of Defense (DoD), the forced uniformity – ostensibly in the interest of cost savings and reducing the influence of the military-industrial complex – between the US Navy (USN) and USAF (exemplified by the September 18, 1962 DoD-directed unification of the military aircraft designation systems using the USAF model) led to two unanticipated negative consequences.

One was the fabled and ill-fated TFX (Tactical Fighter Experimental) program, which produced the bi-service F-111, the A-model being for the USAF and the B-model being intended for the USN. The F-111B proved unworkable as a carrier-based fighter and, in May 1968, the Navy canceled it after having spent millions of dollars developing it. Instead, the Navy bought the Grumman F-14 as its follow-on fleet defender, retaining the McDonnell Douglas F-4B as a multi-role fighter.

The other was the adoption of the Navy's F-4 as the Air Force's follow-on tactical fighter. In fairness, the McDonnell F-4 Phantom II was a great performing aircraft for the 1960s. First flown for the USN on May 27, 1958, the Phantom was designed primarily as a fleet defense fighter, with a secondary ground attack capability. Consequently it had a superior (for its day, and working over water) Westinghouse APQ-72 radar operated by a second crewmember, freeing the pilot to fly the aircraft. It was armed with four semi-active radar homing (SARH) AIM-7 Sparrows and four heat-seeking AIM-9 Sidewinders, both of which were superior to the USAF's AIM-4 Falcon, which came in both varieties. Plus, it could carry 11,000lb of air-to-ground ordnance.

However, it was optimized for fleet defense, meaning that it was specifically designed to shoot down Soviet Naval Aviation Tu-95 "Bear"[2] (fielded in 1955) and Tu-16 "Badger" (1961) bombers attempting to launch AS-1 "Kelt" and AS-3 "Kangaroo" stand-off missiles against the USN's Carrier Battle Groups. For this role the gun – that legendary, simple and reliable weapon of the traditional

BELOW
The F-86 was one of the last truly simple jet fighters that the US built. While the Soviets retained the core principles of simplicity with the MiG-17, MiG-19, and MiG-21, America was developing ever more complex designs. (USAF)

U.S. AIR FORCE
24349
FU-349

BELOW
The MiG-15 typified Soviet-built jet fighters – it was rugged, simple and reliable. This one was test flown by the USAF after a North Korean pilot defected to Japan in it. (USAF)

616
U.S. AIR FORCE

fighter aircraft – was superfluous and only added weight and size to an already large and heavy carrier aircraft.

Because the Phantom was designed as a "bomber destroyer" it had a great appeal to Tactical Air Command (TAC), which was now under the command of General Walter C. Sweeney, Jr.,[3] a dyed-in-the-wool bomber general from before WWII. Thus the F-4 fulfilled both the SAC-driven demand that all new fighters be "nuclear bomber killers" and it provided a greatly increased "iron hauling capability" (carrying conventional bombs to tactical targets) over that of the small F-100 Super Sabre and specialized, nuclear-delivery F-105 Thunderchief. Also, it had the political plus of playing to McNamara's desire to create DoD cost savings by adopting a multi-service fighter aircraft.

The Navy's new F4H-1 had set some spectacular records in Projects *Sageburner* (a low altitude speed record of 902.79mph[4]), *Skyburner* (a high altitude speed record of 1,216.76mph) and *High Jump* (time to climb records to eight different levels up to 30,000m/98,425ft) between August 1961 and April 1962, and in the USAF's Operation *Highspeed* it was tested against the F-106 Delta Dart. It was found to have better overall speed, altitude, range, load-carrying capability and radar. A "complete package" when, in 1962, the USAF adopted the Phantom as its fighter for the 1960s, it was accepted "as is." In fact, the first 29 examples of the Air Force's Phantoms were Navy F-4Bs leased in 1962 as F-110As. The first USAF-specific model was the F-4C, which differed very little from the Navy's B-model.

More versatile than TAC's mainstay, the F-105 "Thud," and able to engage enemy air threats on the way to bombing targets, the Phantom was eagerly accepted (even though it was a Navy airplane) despite the fact that it lacked a gun and required a second crewmember to work the radar. In fact, USAF leaders in the early 1960s planned to have a tactical force composed of F-111s in the air-to-ground and nuclear delivery roles and the F-4 in the air defense and conventional bombing (as well as a tertiary nuclear delivery capability) roles through the decade.

Indeed, the Phantom II proved to be a powerful and effective tactical performer, shooting down 107 MiGs in the skies of North Vietnam (NVN), carrying the brunt of the tactical air offensive into NVN during Operations *Linebacker I* and *II*, and conducting extraordinary numbers of close air support missions in the more permissive South Vietnam and Laotian environments. But being a jack-of-all-trades frequently means being the master of none. Consequently, the F-4 could be faulted as being not particularly accurate as a bomber[5] until the arrival of laser- and optically- (TV) guided bombs in 1970, and its air-to-air capabilites were lacking.

In fairness to the Phantom and its designers, at this time the USAF's fighter pilots lacked air-to-air skills as well. This was primarily because TAC had experienced a very high accident rate with the new F-4 due to its proclivity to depart controlled flight during heavy (high-*g*) maneuvering. This was caused by a severe adverse yaw problem resulting from the sharply swept wing design, which required the aircraft to be rolled with rudder, rather than aileron, during high-*g* turns. At the time TAC was not a combat command but a training command providing qualified aircrews and units to the combat commands overseas. Consequently, General Sweeney was not as concerned with the air-to-air proficiency of his "products" as much as he was with correcting the alarming mishap/aircraft loss rate. He did so by discontinuing the training that resulted in the vast percentage of these losses. The rationale was: why practice something dangerous when we're never going to use it anyway; we're going to kill them all beyond visual range [BVR] with the radar missile.

With little air-to-air training to compensate for the F-4 weapons systems' design deficiencies, the Phantom's flaws as an air superiority fighter became glaringly apparent when it was put up against the current products from the MiG design bureau. In comparison to the MiGs it was large and heavy. Its engines smoked when not in afterburner and they consumed fuel at alarming rates when they were. Its radar[6] was longer ranged but could not see MiGs waiting in ambush by "hiding in the weeds" (below the F-4's altitude, over land); its longer-ranged missiles were hobbled by visual identification (VID) requirements; and it had no gun for close-in combat. However, most of all, the F-4 lacked the maneuverability needed to deal effectively with the more nimble MiGs. Compared to the MiG-17, -19 and -21, the powerful, yet heavy Phantom lacked the agility needed to bring weapons to bear in a classic turning dogfight. As a consequence, the 7:1 kill ratio enjoyed over Korea dwindled to less than 2:1 over NVN.[7]

Aerial Superiority over North Vietnam, A Primer

Overshadowed by the painful toil and bitter losses experienced in the Vietnam War is the fact that the USAF and USN entered the air campaign over NVN with a decided edge and excellent initial results using the all-purpose McDonnell F-4 Phantom II. At the outset the Vietnam People's Air Force (VPAF) only had three dozen MiG-17s at two jet-capable bases, no GCI and no SAMs. However, all this would change with the arrival of Soviet-supplied GCI radars and SAMs, two dozen more MiG-17s and the first supersonic MiG-21 "Fishbeds."

Because the VPAF had to train a modern air defense force from scratch, at first MiG encounters were sporadic. In 1965 one ambush by MiG-17 "Frescos" cost two F-105s lost. This proved that the North American F-100C was inadequate in range, endurance, radar and weapons to provide effective MiG Combat Air Patrol (MIGCAP) and the USAF responded by bringing in Phantoms. Later that year four F-4Cs tricked a couple of "Frescos" into believing they were a delayed flight of "Thuds" and shot down both of them with AIM-7 Sparrows.

This auspicious beginning continued to bear fruit through the following year, with USAF fighters shooting down 12 "Frescos" as the VPAF brought its new MiG-21 "Fishbeds"[8] up to operational standard (losing five in the process). This string of successes culminated on January 2, 1967 in Col Robin Olds' famous Operation *Bolo* in which a MiG sweep by 32 F-4s simulating a full strike package of F-105s, masquerading by using "Thud" callsigns, tanker tracks, and ingress routes and altitudes. Eleven MiG-21s challenged the "raid" and seven were "splashed" for no losses. (The VPAF admits the loss of five.) The successes continued through the first half of 1967, resulting in a total kill-versus-loss tally thus far of 66:18. Counting 30 MiGs destroyed by bombing attacks on their airfields, the VPAF had lost almost its entire initial fighter inventory.

However, in the last half of 1967 the tables slowly began to turn. According to Col Marshall L. Michel III, in his excellent *Clashes: Air Combat over North Vietnam 1965-1972*, this occurred primarily for two reasons. The first was that the learning curve of the VPAF MiG drivers had arrived at an operational level. NVN pilot aggressiveness increased with experience, and tactics perfected by GCI controllers began to place the MiGs at the "six o'clock" of the ingressing USAF formations instead of setting up intercepts in the face of oncoming AIM-7 missiles.

The second reason was not the Phantom itself, but the ill-advised – but ostensibly "fair" – USAF pilot management policy of not forcing any aviator to return to Southeast Asia (SEA) until all had served a tour there. This policy was based on the fallacious belief in the "universally assignable pilot," that is the notion that all graduates of Air Training Command's pilot training program had achieved the same level of proficiency, the minimum requirements to fly fighters. This concept failed to consider the wide spectrum of individual talent, intelligence, adaptability, judgement and follow-on experiences of the AF-wide pilot base. So when those pilots initially manning the F-105 and F-4 squadrons in SEA – most of them highly experienced Korean War veterans who had flown nothing but fighters – "rotated home," they were replaced by interceptor, trainer, transport and bomber pilots whose proficiency in the dynamic and demanding air-to-air environment had entropied to nothing, or by recent UPT (Undergraduate Pilot Training) graduates with no experience whatsoever and no appreciable air-to-air training in their TAC replacement training units (RTUs). Collectively these new wingmen were much less proficient and had more difficulty employing their fighters successfully against a now highly trained and increasingly experienced enemy.

The result was that through the second half of 1967 the MiGs (ably assisted by their canny, all-seeing GCI controllers) increasingly avoided contact when at a disadvantage and caused a mounting loss rate among USAF fighters by engaging in high-speed stern attacks that reduced the F-4's kill:loss ratio to 3:1 during that period. Worse, it plummeted to 0.85:1 – more F-4s were lost than kills achieved – in the first two months of 1968. One can only imagine the heavy collective sigh of relief in Phantom and "Thud" units when President Johnson called for the bombing halt in March 1968. Now at least the USAF could "go to school" on its deteriorating performance and hopefully do better the next time it was called upon to "go North."

The USAF's answer to the problem, unfortunately, was not training (which was the USN's answer[9] when faced with much the same initial experience) but technology. Blaming its equipment, the USAF highly modified its Phantoms to include an internal gun, significant sensor upgrades, and switchology improvements, and greatly enhanced the AIM-7E to the "E-2" variant which included a "dogfight mode." Still, the older F-4D bore the brunt of the renewed combat when the USAF was ordered to "go North" again in Operation *Linebacker*, instigated by President Nixon to finally pressure the NVN leadership to begin negotiating terms for ending the war.

In the hands of the most experienced and proficient F-4 pilots in the USAF – gathered together in the rather elite 555th TFS at Udorn RTAFB – the kill tally only rose to 20 victories for 4 losses, but the MiG-21s' heavy attrition of strike forces kept the overall ratio to less than 2:1. Once B-52s were finally used against NVN in *Linebacker II* (after the North Vietnamese leadership had once again left the peace talks) and employed as they were intended to be – against strategic targets to affect the adversary's will to continue the fight in the "Eleven Days of Christmas" (the title of Col Michel's other excellent treatise on the air war over NVN) – the long, grueling and unsatisfactory conflict was finally brought to an acceptable conclusion.

For a myriad of reasons, the Vietnam War left a lasting, bitter taste in the mouths of USAF officers at all echelons. With regard to air superiority, the solution was now seen as two-fold: technology – as demonstrated by the huge advances in capability built into the F-15 Eagle – and (finally) training. It was no longer enough to merely "build a better mousetrap," but pilots had to be taught how to use it in the intense and unforgiving arena of air-to-air combat. Following SEA the USAF vastly increased its air-to-air training programs in all fighter types, formed aggressor squadrons flying T-38 Talons and F-5 Tiger IIs as adversaries (effectively simulating the small, nimble "Fishbed") and began the famous *Red Flag* exercises that put it all together in heavily opposed, large-force training experiences for the USAF's fighter crews.

THE AIR-TO-AIR "BOX SCORE" OVER NVN 1965–72[10]

Operation *Rolling Thunder*: March 2, 1965–April 1, 1968

Victories		**Losses**	
By F-4 Phantoms	33.5 MiG-17s	To MiG-17s	8 F-4 Phantoms
	25 MiG-21s		8 F-105 Thunderchiefs
By F-105	27.5 MiG-17s	To MiG-21s	10 F-4 Phantoms
			14 F-105 Thunderchiefs
By F-102 Delta Daggers	None		1 F-102 Delta Dagger
Subtotal	86 MiGs	41 USAF Fighters	

Operations *Linebacker I/II*: May 8–December 29, 1972

Victories		**Losses**	
By F-4 Phantoms	8 MiG-19s	To MiG-19s	3 F-4 Phantoms
	41 MiG-21s	To MiG-21s	24 F-4 Phantoms
By F-105 Thunderchiefs	None		1 F-105G Thunderchief
Subtotal	49 MiGs	28 USAF Fighters	
Grand Total	135 MiGs[11]	69 USAF Fighters	

ENTER THE F-X

In late February 1965, however, the first Phantoms had not even arrived in SEA and these deficiencies were not yet apparent when the Air Staff began studying the need for developing the successor to the Phantom. LtCol John W. Bohn, Jr. examined the issue and authored a paper entitled *Force Options for Tactical Air* that proposed a "high-low mix" future force structure. Prompted by intelligence estimates that suggested that Soviet interceptors posed a greater threat than had originally been envisaged, LtCol Bohn's paper proposed the combination of a few high-tech (and high dollar) air-to-air fighters to sweep the Soviet defenders from the sky and a host of low-tech (ie cheap) air-to-ground fighter-bombers to pound the enemy into submission. Bohn originally suggested that the Northrop F-5 fulfill the latter role (in reality it was the Vought A-7 that did so) but since the F-111 had by this time disqualified itself as a fighter (and would serve only as a bomb-dropper with an "F"-designation) Bohn recommended that a new high technology fighter specifically designed to achieve aerial superiority – placing emphasis on maneuverability instead of speed – be developed in the near future.[12] CSAF (Chief of Staff of the Air Force) Gen John P. McConnell endorsed the study and Eugene M. Zuckert, Secretary of the Air Force (SECAF), allocated $10m for FY66 (Fiscal Year 1966) for further studies leading to the design of the ultimate US fighter.

These studies were both in-house evaluations by various branches of the USAF Headquarters (HQ, known as the Air Staff) in the Pentagon, the Air Force Systems Command's (AFSC's) Aeronautical Systems Division, and aerospace contractor studies, the latter prompted by a series of requests for proposal (RFP). The first was for a general "Tactical Support Aircraft" and was sent out on December 8, 1965 to 13 different companies. Eight responses were received and in April 1966 HQ USAF selected Boeing, Lockheed and North American Aviation to take part in a four-month Concept Formulation Study (CFS), requiring them to submit a range of designs tailored to the USAF's needs.

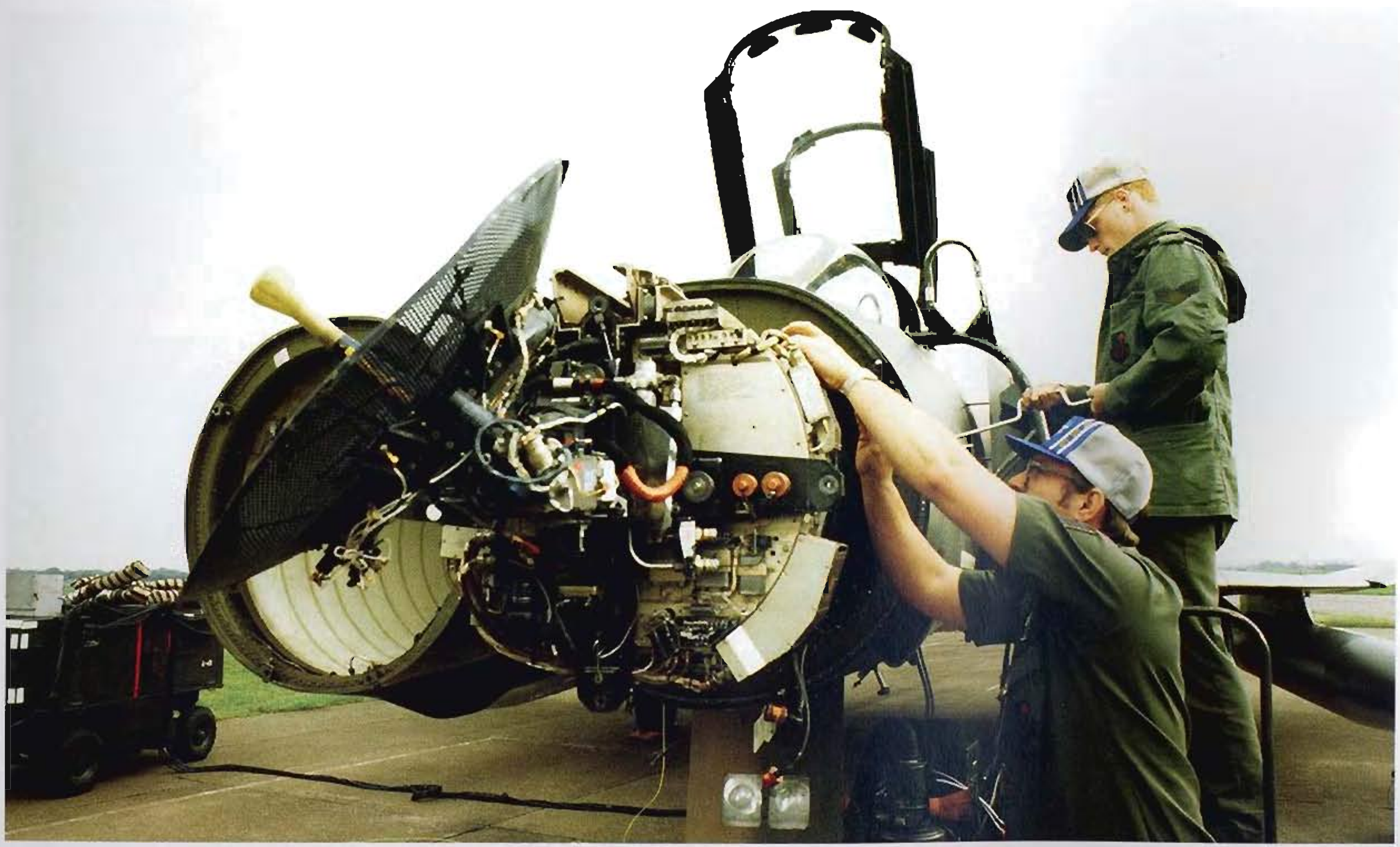
BELOW
The F-4D was introduced to units in Vietnam in May 1967. It was the second version of the Phantom II built for the USAF and incorporated more USAF-specific capabilities. One of these was the ability to employ the AIM-4D. This missile proved even less capable than the troubled AIM-9B. (USAF)

Of the 500 designs submitted in October the following year, the USAF rejected all of them. None of them offered an airframe that would be optimized for the air-to-air role. Caving to the prevailing mantra of multi-role cost-effectiveness, and the prospects of selling the resulting product to both the Navy and AF, all had made concessions for the air-to-ground mission, compromises which the Air Staff deemed counter to the goal of an air superiority fighter. Significantly, all of the designs conformed to similar proposals offered for the TFX program only a few years before: each employed variable geometry (VG, or "swing") wings, each toted two high-bypass ratio turbofan engines, and they shared avionics compatibility with the F-111. Expanding on the TFX model that bigger is better, weight figures of some of the proposals had ballooned to nearly 60,000lb!

In July 1967 the Soviets unveiled the MiG-25 "Foxbat" at the Domodedovo air show. It was a high-flying Mach 2.8 interceptor designed to counter the A-12 series of high-fast spyplanes and the XB-70 bomber.[13] The "Foxbat" sent shockwaves through the upper echelons of the USAF. In a two-year period, the MiG-25 was to further shock the West by breaking a number of world speed and time-to-altitude records. Although it was learned much later that the MiG-25 was far less capable than the Soviets had intimated, at the time it provided the final impetus needed to spur the Pentagon and the American aerospace industry to produce what would ultimately become the F-15. The unveiling of the "Foxbat" paved the way for a second RFP on August 11, 1967. This request specifically asked for concept development of a "Fighter" and went to all the contractors that had responded to the first RFP. By this time the conceptualized air-to-air fighter – ostensibly needed to beat the MiG-25 – was referred to as the "F-X," meaning "Fighter-Unknown Number Designation" (not "Fighter Experimental") and it was clear that F-X was to replace the F-4 Phantom.

The second RFP opened the door for unauthorized and initially unpopular work carried out by Maj John R. Boyd to take center stage in the future of fighter aircraft design. Boyd, a test pilot and Korean War veteran (122 combat missions in the F-86 Sabre), had developed a mathematical formula for defining the hypothetical performance, and hence, design of the modern jet fighter. It was called the Energy-Maneuverability Theory. This concept, first published in May 1964, had been given little attention to date. It argued that a fighter's performance should be characterized by its potential and kinetic energies, each of which could be changed by maneuvering the aircraft around the sky. It was this theory that would later mature into the Energy Maneuvering (EM) graph that fighter pilots now study to determine how many gs they can pull and how fast they can turn their nose towards an opponent during combat. The EM graph allowed designers to take an aerodynamic shape and plot what energy state, lift, drag and other criteria would be placed upon it at a range of altitudes and airspeeds. Armed with this information, and using expensive mainframe computers, they were able to determine how well it would maneuver and, importantly, which portion of the flight envelope it would perform in best. The key advantage this system afforded was the ability to define tactics by studying a relatively straightforward graph, and identifying which flight regime offered the best performance

BELOW
The Phantom's radar operated reasonably well in the look-up environment, but in look-down scenarios was blinded by ground clutter. The radar was ideal for targeting high-altitude nuclear bombers, but for detecting small, nimble MiGs in the weeds of Vietnam, however, it was inadequate. (USAF)



advantages; it also predicted how well one jet might operate against another by comparing graphs for both aircraft. Thus, for the first time, aircraft designers could identify the weak spots of a potential adversary and design an aircraft that could exploit them.

DEVELOPING THE DESIGN

Prompted by the dramatic appearance of the "Foxbat," the August 1967 RFP was a request for selected aerospace companies to produce a Concept Development Package (CDP) and Technical Development Plan (TDP). To counter the MiG-25 the concept fighter to be proscribed by this iteration would need to have a fantastic rate of climb (it therefore needed very high thrust) to get near the "Foxbat's" altitude quickly and a powerful radar able to detect it at long range, yet it should retain the ability to counter more numerous light and nimble MiGs of the older generation.

The CDP consisted of four main areas for specific consideration: ensuring through wind tunnel tests that the aerodynamics worked; identifying suitable engines which would propel the F-X to its target top speed of Mach 2.5 and offering enough excess thrust to power the aircraft through combat maneuvering; determining a good armament combination and avionics suite; and finally, deciding whether it should be crewed by one or two individuals. The TDP was to detail the development schedule for the contender's airframe. The request to provide these two products was sent to all seven companies[14] that had responded to the initial RFP in 1966.

BELOW
Little was known about the MiG-25 "Foxbat" when it was revealed in July 1967. As US intelligence analysts clambered over each other to warn of the threat it must surely pose, extra urgency was instilled in the F-X program. (USAF)

The wind tunnel testing mentioned in the CDP was undertaken by the National Aeronautics and Space Administration's (NASA's) Langley Research Center, which had five different wind tunnels, including a supersonic one, to assess various aspects of the prospective designs. The Langley facility had been closely involved with the development of VG-wing technology for the TFX program and following the advent of the "Foxbat" the facility undertook an in-house evaluation of various wing, fuselage and engine location configurations. Some 41 NASA researchers and engineers studied four basic configurations: the popular VG wing; a conventional layout with fixed wing and fuselage-embedded engines; fixed wing with wing-mounted engines; and one that imitated the layout of the "Foxbat." The results were made available to the prospective contractors for their own F-X design development. While NASA determined that VG-wings were the most appropriate for carrier-based fleet defense fighters (thus these were adopted for the contemporary F-14), the fixed sweep wing made a strong impression on the McDonnell Douglas[15] design team. Doing without the extremely heavy wing pivot structure and actuating mechanisms meant significant weight savings which, paired with the right engines, could achieve a thrust-to-weight ratio of nearly 1:1 and thus produce an extremely high performance dogfighter.

Finding "the right engines" was AFSC's responsibility, and it was looking for a large afterburning turbofan. Afterburner (A/B) augmentation is what gives a military jet engine powerful additional thrust for maneuvering and acceleration, but at the expense of hugely increased fuel consumption. High-bypass turbofans – the major engine development of the 1960s – used a second set of exhaust turbines to spin large diameter multi-stage fans to push huge volumes of cool air past the "core" turbojet encased within, vastly increasing the basic engine's steady-state thrust and fuel efficiency. The concept of mating the great cruise economy of a turbofan and the high thrust on demand of the afterburner, promised economical cruise over long distances into the target area and great power available for acceleration (to engage) and maneuvering (to kill).

AFSC's first proposal was for an augmented (A/B-equipped) turbofan with a bypass ratio of 2.2:1 (2.2 volumes of air via the fan bypass for each equivalent volume of air through the core turbojet). However, knowledgeable pilots such as John Boyd opposed it saying that a 0.9:1 (almost equal flow of cool fan air and hot jet exhaust into the A/B section) was preferred because it made for more efficient afterburner operations. In combat, Boyd argued, an efficient afterburner was more important than fuel economy. Initially a compromise of 1.5:1 was agreed and studies were sourced to General Electric (GE) and Pratt & Whitney (P&W) while AFSC's Aeronautical Propulsion Laboratory undertook its own evaluation.

At this stage (1967), Dr. Harold Brown, the DoD Director of Defense Research and Engineering and author of the notorious TFX fiasco, stepped in and directed that both the Navy and AF use the same compressor/turbine core for their future afterburning turbofans (for the improved, re-engined F-14B and F-X) eliminating the opportunity for further optimization and setting the ratio for the F-X's concept motor at 0.7:1, increasing operating temperatures, compression ratio, weight and cost in so doing. While 0.7:1 was better than 1.5:1, by this time further studies had determined that 0.6:1 was best.

The two contractors' studies were completed in September 1967 and the USAF was given the lead to develop the common engine core the following April. The joint program went by the name Advanced Turbine Engine Gas Generator (ATEGG), and drew on experiences learned through the P&W TF30, the engine which powered the troubled F-111 bomber and the F-14A. It included design goals to improve thrust output, reduce weight and achieve a minimum thrust to weight ratio of 9:1. GE, General Motors (GM) and P&W were sent RFPs in April 1968. GM was eliminated from the program four months later, leaving P&W and GE to complete a $118m contract for the initial engineering development of the F-X engine.

Although the F-X would initially utilize newer, improved versions of the AIM-7 and AIM-9 missiles, a powerful new radar was needed that could see small radar-cross-section (RCS) targets, such as the MiG-21, at great ranges and be able to look below the altitude of the F-X fighter to find such targets against the heavy electronic clutter known as "ground returns." As the USAF had experienced in SEA, opposing fighters could "hide" among this clutter and be almost impossible to differentiate from the many extraneous returns.

The solution to this problem was in the development of Doppler radars. Since its invention, radar had worked on the concept of sending out a pulse of energy. By measuring the time for that pulse to be reflected back to the radar, the range to the target could be determined. Doppler radars worked on the theory (devised by Dr. Christian A. Doppler, in 1842, to measure the movement of stars and other celestial bodies) that returns from approaching targets would be compressed by the closing speed of the target, increasing the frequency of the returning pulse. Conversely, a target that was going away would reflect back a pulse that would be expanded – and thus at a lower frequency – than its original form.[16] By measuring the changes in the frequency in the returning pulse it is possible to determine whether the target is approaching or departing and at what speed.

BELOW
Just the size of the MiG-25's exhaust nozzles implied that the aircraft was very powerful and capable of extreme performance. (USAF)

But, like all radars a Doppler unit also has a ground return, that is the return of radar energy whose frequency has been compressed by contact with the ground commensurate with the speed of the aircraft carrying the radar. However, computers – even at that early stage of development – could apply filters to the radar receiver so that all returns in the frequency band related to the fighter's speed would be ignored, effectively blinding the radar to the ground return. Using this filtering, the Doppler radar could see targets below the fighter's altitude if they were approaching or going away, but not those passing 90 degrees to the fighter's flight path and hence showing up with the same Doppler frequency shift as the earth beneath it.

BELOW
There were many factors that influenced the disappointing overall performance of the USAF's, USMC's and USN's F-4s against MiGs in Vietnam, but one of the most obvious was the poor performance of the AIM-7E Sparrow missile. It ended the war with a success rate of less than 10 percent, and 66 percent of the 612 actually launched had not functioned properly. (USAF)

LT-DATE
1336
HSMS-24
GSE
MAX-LOAD
4000LBS
LT-DUE
2336

The problem with Doppler was that while a target could be seen at a certain azimuth (generating a shifted-frequency return at that angle) there was no inherent range information provided by the return. However, emerging computer capabilities provided a means of encoding each pulse with an identifying electronic signature and the ability to read that code and thus be able to time the transmit-and-return (and thereby measure range) of each pulse, even if its frequency had been shifted by the opening or closing velocities of the target. Additional electronic technologies provided much greater transmission efficiency, allowing the radar to emit a high-power (long range) pulse in a brief instant and then "listen" for a much longer duration. The combination of pulse coding (providing range data) and Doppler shifting (providing look-down capability) resulted in the concept of the pulse-Doppler (PD) radar sought by the Air Force for its new fighter.

In the meantime, both Hughes and Westinghouse had developed Doppler radar technology for practical application and were poised to work it into the sophisticated fighter-size package needed for the F-X. In March 1968 they were issued competitive awards to provide a useable long-range, look-down radar.

The decision to make the F-X a single-seat fighter is credited to Col John J. Burns, Director of Operations (DO) of the 8th TFW "Wolfpack." Col Burns was a WWII and Korean War veteran, having flown the P-47 Thunderbolt in 106 combat missions in the European Theater of Operations (ETO), 102 missions in the F-84E Thunderjet in Korea, and commanded the first McDonnell F-101A (single-seat) squadron and later F-100 Super Sabre units at RAF Bentwaters. Most recently he had been the Chief of Requirements (DOR, or, more formally, Director of Requirements) at HQ TAC after flying the F-105 with the 4th TFW at Seymour Johnson Air Force Base (AFB), NC, and being the head of Category II testing of the F-4 at Edwards AFB. He arrived at Ubon Royal Thai Air Force Base (RTAFB) in May 1967 when the MiGs were beginning to effectively counter American aerial superiority over NVN with stern pop-up attacks from low altitude.

Col Burns maintained that the two-seater was an unsuccessful aberration in US fighter development. The USAF had not had a dedicated radar operator in its cockpits since the F-94 Starfire was replaced by the single-seat Convair F-102 and F-106s in the air defense role and he felt that with sufficient automation, the radar and aircraft could both be operated by a single person.

Additionally, in recent combat in SEA the "second set of eyes" (which were usually those of a new pilot freshly graduated from pilot training and not a dedicated Weapons System Operator [WSO] at this stage) had proven to be of little benefit, while the high intra-cockpit coordination and communication requirements "in the heat of battle" most often resulted in confusion and missed shots. Usually it was ground controlled intercept (GCI) radar controllers, not the "back-seater," who saw the MiGs pop up behind the F-4s and gave the warning that they were "at 'six o'clock' and closing fast," necessitating a sudden, high-g "break turn" to come about to face the threat. The sudden surprise, the high-gs and the very short time available for the back seat pilot/radar operator to find the attacker and get a radar lock resulted in confusion and poor intra-cockpit communications at a very critical time. Some 50 AIM-7 misses had been reported due to these factors since the beginning of the air campaign over NVN. Therefore, Col Burns felt strongly that the USAF should return to a single-seat fighter if sufficient automation in operating the radar was technologically feasible.[17]

Engineers at AFSC's Aerospace Systems Division agreed with Col Burns, estimating that as much as 5,000lb weight saving could be realized by eliminating the additional systems and structure required by the second crew position.[18]

The winning bid would be the one which combined these primary components – airframe, engines and radar – into the most efficient (in terms of cost), effective and maneuverable combination. The process was very much aided by the use of Boyd's EM theory and it proved instrumental in the second round of proposals. For one thing, it showed that the projected weight of the F-X could be reduced to 40,000lb. Boyd argued that it should be even lighter.

Fortunately for McDonnell Douglas, the company had continued to develop its initial F-X design study with in-house funding, despite not being selected to participate in the CFS the year before. Because of this, its team was well placed to pick up the gauntlet even at this late stage. Once it realized from the NASA tests that the weight savings achieved by discarding the heavy VG-wing apparatus[19] made it possible to build a very robust airframe-engine combination in the 40,000lb category, "McAir" (as the company was called in the industry and the USAF) was onto the winning formula.

Meanwhile, Lockheed, Grumman and General Dynamics continued their preference for a VG-wing. Fairchild Hiller and North American were the only others who departed from this configuration, the first favoring the engines-in-the-wings configuration, the second adopting an advanced blended wing-body layout. Consequently, on December 1, 1967 the USAF chose one contender from each of the two schools of configurations: McDonnell Douglas with the fixed-wing design, and General Dynamics (GD) using VG technology from its experience with the F-111. Contracts were awarded to these two for a second six-month CFS for them to refine their F-X proposals.[20]

The major issue muddling the continuing process of design development was the fact that by now the "blue suit" Air Force (Strategic Air Command) wanted a specialized air-to-air fighter but

BELOW
Some of the F-X requirements were less about technology and more about common sense. This photograph demonstrates the limited rearwards visibility from the F-4. This was fine when intercepting Tu-95 "Bears" as shown here, but ill-suited to "checking six" and dogfighting MiGs. (USAF)

the AF's civilian masters (SECAF and his staff) wanted to retain the multi-role capability. So, despite repeated attempts to have the air-to-ground requirement removed from the CDP request, the USAF was compelled to retain it, much to the dissatisfaction of those USAF officers who felt that a compromise could never adequately provide the kind of fighter needed to combat current and future Soviet opponents.

At this stage the true customer, HQ TAC, weighed in to make its preferences and requirements known. By this time TAC had changed into a combat (versus training) command, responsible for providing units (as well as training aircrews) to the overseas commands in Europe and the Pacific. Following a series of conferences hosted by TAC at Langley AFB, Virginia, TAC could speak for all three tactical combat commands (TAC, United States Air Forces in Europe [USAFE], and Pacific Air Command [PACAF]; collectively known as the Tactical Air Forces or TAF) in ordering its next generation fighter. By this time the lessons learned the hard way by TAC and PACAF F-4 units in the skies over NVN had filtered back to the halls of their HQs and the multiple needs for change were recognized and being worked on. Fighter aircrew training changed dramatically; the next variant of the F-4 included wing leading edge slats to increase maneuverability and a nose-mounted 20mm cannon for close-in combat. But most importantly, the warfighters of the TAF recognized the need for a dedicated air-to-air fighter to sweep the opposing MiGs from the skies and allow the bomb-droppers to do their job effectively and with impunity. In February 1968, TAC completed the TAF's Required Operational Capability (ROC-9-68) statement affirming that any F-4 replacement would have to be an air superiority fighter.

TAC's requirement was for a high performance fighter optimized to engage and kill its adversaries BVR. Once they closed to the "visual arena" it should be able to outmaneuver the enemy to gain a shooting advantage. Although the inclusion of an internal gun was not specified, it went without saying that the lack of one would disqualify the competing contractor. Gen Gabriel P. Disosway, Commander in Chief (CinC) TAC, signed ROC-9-68 – a document that was largely a product of Col John Burns' requirements office when he was TAC/DOR – and forwarded it to HQ USAF for inclusion in the F-X design process. Three months later, in May

F-X Design Requirements

The September 1968 RFP required the F-X design submissions to provide a fighter with:

1. Wing optimized for high load factor (g) and buffet-free performance at Mach 0.9 at 30,000ft altitude;
2. High thrust-to-weight ratio to achieve very high energy maneuverability throughout the flight envelope;
3. Mach 2.5 maximum speed at altitude;
4. Long-range pulse-Doppler radar with look-down capability;
5. One man operation of the weapons system for all missions;
6. Advanced cockpit layout, displays, and controls, which would allow heads-up operation during close-in combat;
7. Airframe fatigue spectrum with a life of 4,000 hours;
8. 360 degree cockpit visibility;
9. High maintainability: 11.3 maintenance man hours per flight hour (similar to WW2 fighter requirements);
10. Significant increase in avionic and airframe subsystem component mean time between failure (MTBF);
11. Highly survivable structure, fuel, hydraulic, flight control and electrical subsystems in a combat environment;
12. Self-contained engine starting without need for ground support equipment;
13. Global (intercontinental) ferry range with or without aerial refueling;
14. Maximum air superiority mission gross weight in the 40,000lb class;
15. Low development risk components (engine and radar) and airframe subsystems which had been proven in prototype, pre-production, or production applications.

Source: Stevenson, James Perry *McDonnell Douglas F-15 Eagle*, Aero Publishers, Fallbrook, CA, 1978.

1968, CSAF Gen John P. McConnell endorsed TAC's ROC and assigned the F-X the Air Force's highest priority. The USAF would have air superiority and it would have it as soon as possible.

FROM F-X TO F-15

In June 1968 the USAF took the results of the contractors' proposals for evaluation. Several factors caused considerable disagreement among the 100 or so individuals assigned to the review board, but none more so than the avionics suite. The disagreement stemmed from the rather schizophrenic concept still being pursued by the USAF. While the TAF were convinced that only a specialized air superiority fighter would do (and the CSAF endorsed that requirement), the Air Force's civilian masters had ensured that the ground attack requirements were retained in the CDP. Therefore, the review initially hung up on something the TAF warfighters did not want anyway: whether or not the design should retain a terrain following radar (as in the F-111) and related all-weather bombing systems. These would allow the aircraft to bomb targets when they may not be visible to the pilot and to fly at low level at night and in poor weather. Advocates argued that it should, especially given the fact that technology was advancing rapidly enough to allow the carriage of such systems with only a small weight penalty. Those against the idea argued that there were unacceptable risks in making such assumptions and that, in any case, these items were not essential and were costly overall.

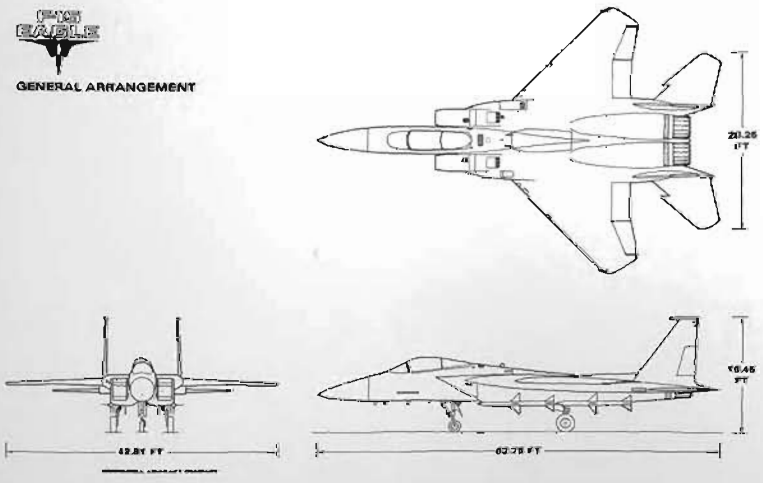
There were also strong voices among the ranks of the SEA-experienced fighter pilots on the Air Staff, who reasoned that the high-tech, yet maneuverable, 40,000lb missile-shooter was never going to succeed and that a smaller 25,000lb fighter with simple avionics and super-maneuverability was the way forward. Boyd was one of those to argue this point. Many of these veterans had witnessed the devastating effectiveness of NVN MiG-21s against the heavier and visually more discernible F-4. Indeed, this had been confirmed by secret USAF and USN projects in remote ranges in Nevada, where secretly acquired MiGs had been flight tested and evaluated against nearly every fighter in the US inventory. In many respects, this band of dissidents – known infamously as the "Fighter Mafia" – was right to be skeptical of the success of what, to them, looked like just another F-4.[31]

The review, with inputs from TAC, the Air Staff, NASA and the American aerospace industry, culminated in the Development Concept Paper (DCP) signed by the (now) SECAF Harold Brown in September 1968. The DCP had determined that the aircraft was to be a single seat, twin turbofan powered fighter of not more than 40,000lb. It would have a thrust-to-weight ratio approaching 1:1 at combat weight; a maximum speed of Mach 2.5; 360° view outside the pilot's cockpit and advanced display and controls layout inside; be capable of flying a 260nm mission on internal fuel and able to deploy to Europe without inflight refueling (with external fuel tanks); and have a long range pulse-Doppler radar with a look-down capability. In plain English, the USAF finally stated unequivocally that it wanted a single seat fighter with twin-engine survivability which could outmaneuver and out-gun any enemy fighter in the world, either BVR or in the visual arena. In addition, the USAF decreed that the engine, radar and other major components would be tendered for on a prototype basis – a move designed to attract the best systems at the least risk to the Air Force. The fly-away cost was estimated at around $5.3m per aircraft. The F-X airframe, once chosen, was to be designated F-15.

The DCP resulted in the third RFP, this one for contract definition, being released on September 30 to the seven original contractors, plus LTV (Ling-Temco-Vought). Evaluating the responses three months later the USAF awarded $15.4m contracts to McDonnell Douglas, North American Rockwell and Fairchild Hiller for the final stage of development. These three contractors – none of which used the VG configuration – were to determine the definitive layout and provide prospective performance figures for each of their preferred designs. The RFP called for each of the three companies to provide their final design by June 30, 1969.

Under the headline banner *F-15 Program in High Gear*, McDonnell Douglas' February 1969 edition of *Airscoop* reported that there were already 600 engineers working on the company's design, a figure set to rise to 1,000 by March that year. This was significant, as was the company's decision to centralize the F-15 workforce into Building 1 at St. Louis, because McDonnell Douglas had until that point been more focused on tendering for the Navy's VFX competition. This was more telling than it might at first appear. According to Paul Homsher, deputy general manager of McAir's F-X contender, the company had such a strong tradition as a Navy contractor that it had formed the view it was more likely to win the VFX competition than the F-X campaign. As such, most of the company's efforts had been channeled into meeting the Navy's requirements. Donald Malvern, the general manager of the F-15 program and Homsher's boss, was somewhat irritated and a touch dejected by his own bosses' infatuation with the VFX jet, Homsher recalled, and one gets the impression that McDonnell Douglas had somewhat neglected the F-X competition in the early days, with a low of fewer than 200 people working on the proposal.[22] Equally as telling, James S. "Sandy" McDonnell, then president of the McDonnell Douglas Corporation, in the same issue of *Airscoop* wrote in an open letter to "All Temmates [sic]" that: "we have assigned our top engineering, management and production talent to the team that will devote its full time and energies to this most important task.[23] This F-15 team will need the support of everyone if we are to win the Air Force competition." "Mr Mac" was cutting things finely.

BELOW
This McAir general arrangement diagram shows that the F-15 was to be an impressively big fighter. (Boeing via Steve Davies)



The three responses – from McDonnell Douglas, North American Rockwell and Fairchild Hiller – to the final RFP were all received on time in June. McAir's proposal was the most comprehensive it had ever prepared, consisting of 37,000 pages that stood 11ft tall. McDonnell Douglas went with the conventional layout with twin fins. North American Rockwell's was an advanced blended wing-body proposal with fuselage-embedded engines and a single fin, and Fairchild Hiller's design had wing-mounted engines, a "cranked" wing and a single fin. For the next six months the USAF's F-15 Systems Project Office (SPO) evaluated the proposals.

McDonnell Douglas' effort, and 2,500,000 man hours of work, paid off at 16:20 hours, Tuesday, December 23, 1969, when (BrigGen) Benjamin N. Bellis, the Air Force's system program manager for the F-15, telephoned "Sandy" McDonnell in St. Louis – McAir had won the F-X competition.

CR
081
CR
082

02

THE MCDONNELL DOUGLAS 199-B DESIGN

The Aircraft Company division of McDonnell Douglas – the famous McAir – was to prepare for an eventual production run of 749 airframes, provided, of course, that its winning design could be produced within given financial guidelines.[1] The company was tasked by the Air Force to produce 20 test aircraft and then to deliver: "a first wing of 107 F-15 aircraft at a not-to-exceed ceiling price of $936,591,000."[2] The test aircraft were to be manufactured at a cost of some $1,146,385,000.

McDonnell Douglas' design would incorporate avionics, flight controls, electronic warfare systems, weapons delivery capabilities and levels of maintainability never before seen. The Eagle would boast a large number of "firsts" and would be developed in such a way that these facets would all combine to make the ultimate air superiority fighter.

CONSTRUCTION

McDonnell Douglas had spent more than 23,000 hours wind tunnel testing over 100 different wing/body combinations before it felt it had the best wing shape for what it now termed its 199-B design. Considerable time was spent optimizing the airfoil for minimum drag in both low- and high-altitude flight regimes. What resulted was a sophisticated, highly cambered wing shape devoid of any high-lift devices as seen on the slatted F-4E, and one which conferred excellent maneuverability, even under high g-loading. Because the Eagle had only a simple flap and aileron on each wing, assembly and maintenance were straightforward. Less obvious, though, was that McAir engineers had built a three-spar wing with redundant load paths that would allow the Eagle to sustain significant battle damage to its wing without losing the capacity for control throughout the basic maneuvering necessary to limp home and land. Joe Dobronski, Irv Burrow's boss, concluded that: "agility throughout the flight envelope of the F-15 belies its size. Its light and responsive control system, along with low wing-loading[3] and high thrust-to-weight ratio, result in exciting flight control characteristics for air combat maneuvering."[4] They also allowed a 16 degree per second instantaneous turn rate and a refreshingly slow landing speed of around 120 knots.

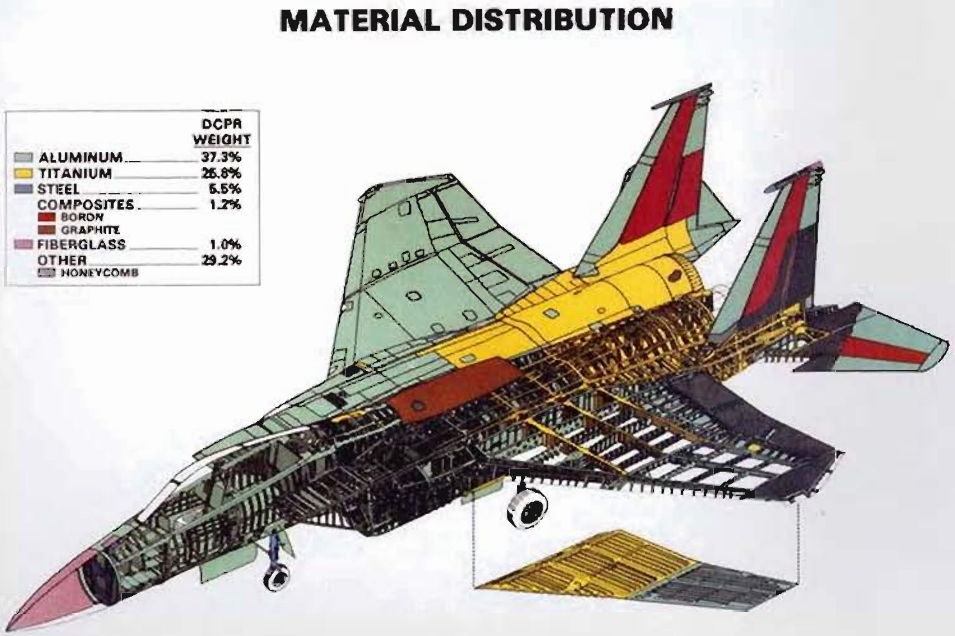
From the outset, McAir's F-X contender had been designed to be easier to manufacture and maintain. New manufacturing techniques and materials would allow it to be built in a shorter time period and with less production effort. The fuselage was simple in construction, built from a mere three sections assembled to form a whole, and had a 4,000-hour fatigue life (300 percent more than the F-4). This was a stark contrast to the F-4, where

OPPOSITE
Two of the "Queen's Finest" on NATO air defense patrol over the Dutch coast. These two brand new F-15As, of the 32nd TFS, Soesterberg AB, Netherlands, carry a full war load of early (white) AIM-7Fs and (then) new AIM-9Ls. Both were delivered in late 1978 and served with the 32nd until May 23, 1980, when they were replaced by new F-15Cs. In late 2006, 77-0082 was stored at the Aerospace Maintenance and Regeneration Center, Davis-Monthan AFB, Arizona, while 77-0091 was still active with the Louisiana Air National Guard's 123rd FS. (USAF)

lots of small pieces combined to make a heavy, awkward and labor intensive fuselage section. By way of illustration, 690,000 production hours had been set aside to build the first six airframes; McAir managed it in 466,000 hours. Despite being of similar dimensions to the F-4 it was due to replace, simpler manufacturing techniques and lighter materials (such as titanium and composites) made it 6,000lb lighter.[5]

The team effort required to build the F-15 would eventually involve no fewer than 4,000 other subcontractors. Fabrication was first on the list. Aluminum, titanium, steel, fiberglass, and composites materials, such as boron epoxy and honeycomb, were all used by the "tin benders"[6] to create the many pieces that made up what had now been named the "Eagle." Titanium was particularly important – although tough to work with – because it was key to allowing the "big bone" parts of the F-15, such as bulkheads, to be strong and light-weight at the same time. Working with this tough metal required the use of multi-axis, multi-spindle, computer-controlled profilers, which could machine a 1,250lb billet of titanium into a complex 145lb bulkhead. Titanium would make up 25.8 percent of the airframe (versus 9 percent in the F-4), forming the full-depth fuselage keel, wing spars, stabilizer frames, torque boxes and individual engine bays.

BELOW
The overwhelming majority of the F-X would be constructed from aluminum and titanium. Titanium would make up 25.8 percent of the airframe compared to 9 percent in the F-4. (Boeing via Steve Davies)



To cater to the extensive avionics and electronics built into the airframe, miniature compact wire bundles – which were another weight-saving innovation – had to be braided by hand across long tables that had pegs hammered into them to allow the technicians to lay out the cabling neatly. In all, the F-15 required nearly 19 miles of cabling, but its wire bundles weighed 45 percent less than those of comparable length installed on the F-4.[7]

Come October 1971, McAir had more than 4,800 people working for Malvern on the F-15 program. The company was on track to get the F-15 into the air for the first time in July 1972, and BrigGen Bellis was pressing McDonnell Douglas to stay on track with the Air Force's urgent requirement to get the F-15 into service as soon as possible. 199-B was on schedule, on performance and on cost. For reasons beyond the control of Malvern and his team, it would not stay that way for much longer.

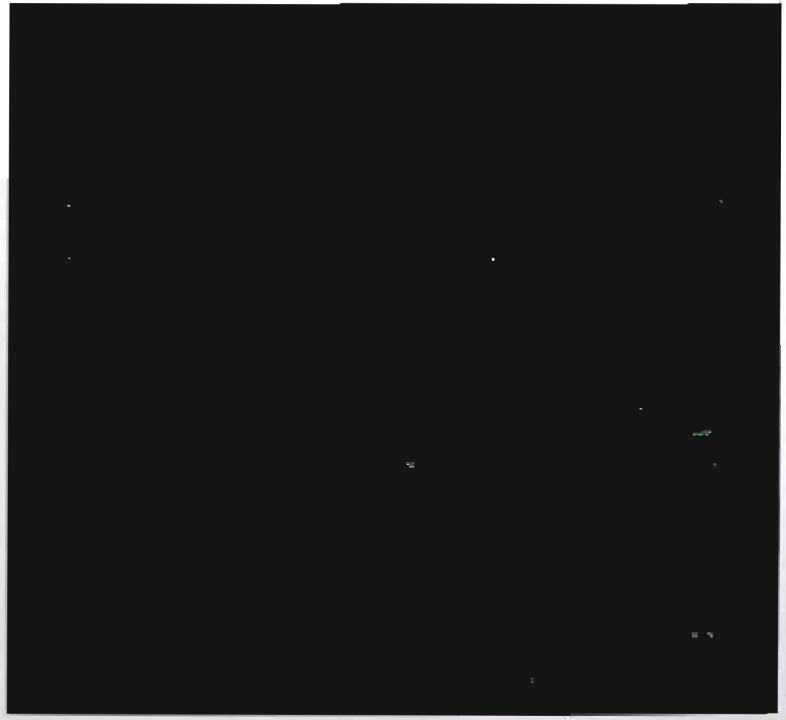
THE CENTRAL COMPUTER

The F-15's avionics and weapons systems were to be the most sophisticated fielded in any fighter at that time. They would be tied together and controlled by an IBM CP-1075/AYK central computer (CC), a 48.5lb high-speed, general-purpose, analog computer of a kind never before seen. It had a "hard-wired" memory of 16.3K – 34-bit – words, expandable to 24.6K, to "remember" the weapons envelopes (for both air-to-air and air-to-ground ordnance, the latter to satisfy Congress) and aircraft flight performance data. Its computation speed of 340,000 instructions per second was used to convert the data sent from subsystems onboard the aircraft into useful and readable information displayed to the pilot on the heads up display (HUD), vertical situation display (VSD, or "radar scope") and horizontal situation indicator (HSI, the primary navigation instrument).[8]

The concept of the CC was an innovation of McAir in response to the USAF's requirement that the F-15 be more deadly with just one occupant at the controls than the F-4 Phantom II had ever been with two men dividing the workload. The CC contained the complete weapons engagement zone (WEZ) data for the AIM-7 Sparrow and continuously calculated the dynamic launch zone (DLZ) on a real-time basis. In addition, at the insistence of the Air Force's civilian masters, it also contained the ballistics and release parameters for all possible air-to-ground ordnance the F-15 could carry. That left little memory to store AIM-9J/P WEZ data, but since these versions of the Sidewinder were rear-aspect ("stern-only") missiles in the early days, this was not a problem. For example, the memory capacity of the earliest CC was so limited that the F-15s used in the AIMVAL/ACEVAL (Air Intercept Missile Evaluation/Air Combat Evaluation) tests in 1977 had to have their CCs "rewired" to replace the air-to-ground data with WEZ information to simulate the AIM-9L or other front-aspect IR-missile concepts under evaluation. This amounted to an "electronic lobotomy," excising from the CC's memory the unwanted air-to-ground information and replacing it with a much more dynamic – and therefore more memory-intensive – front-aspect WEZ information. When the AIM-9L came into service as the final F-15A/Bs were rolling off the production line, the CCs were given an upgrade to 24.6K bulk memory (essentially by soldering in an additional 8K memory card) to cater for the additional WEZ data for the "Lima."

Only the successful integration of the CC into the heart of the aircraft would make it possible for a single pilot to harness the Eagle's full potential and by the time McAir was done, the CC would interface with a total of 14 different onboard systems,[9] freeing up the pilot to manage and employ the Eagle's weapons. In developing the CC, it had become apparent in the mid-1960s that computing technology had matured to a stage where it could be applied to the Eagle. Don Malvern cited this maturing of technologies, and, notably, that so many became practical at the same time, as one of the key factors that allowed the F-15 to develop into what it would become. Integrating a computer into the Eagle to do the job of a human was no small task, but the ever diligent engineers at McAir managed it with style.

The CC communicated with the rest of the aircraft's systems via an H009 multiplex bus (called a MUX), which provided both the means of data transfer and the scheduling of that transfer to two aircraft avionics interface units (AIUs). These AIUs operated as interfaces between aircraft systems and the MUX. Key among those systems interfaced by the CC were the radar and Tactical Electronic Warfare Suite (TEWS), the ears of the Eagle, in a sense. Without a computer to interpret all of these many sources of data, the Eagle's potency would be seriously degraded.



RIGHT
The symbology generated by the radar gave the Eagle pilot a "clean" scope that was devoid of clutter and false radar returns. Around the edge of the scope were readouts relating to the radar parameters, the target's parameters, and to the right, the dynamic launch zone for the selected missile. An azimuth steering error (ASE) circle in the middle showed the pilot how far off boresight he could launch the missile, although in an ideal world he would steer to place the steering dot in the middle to give the missile the best chance of success. In this image, the locked target is the small square at the bottom of the ASE. The rate of closure is 184 knots and the target is 8 miles distant. The "IN RNG" cue tells the pilot the target is within lethal range of the missile, and the two tick marks on the right show the maximum and minimum range of the missile. As time progressed, the Eagle's CC was upgraded to allow the VSD to display ever more complex information, and today's Eagle VSD is a far cry from this simple picture (see image on page 178). (Boeing via Steve Davies)

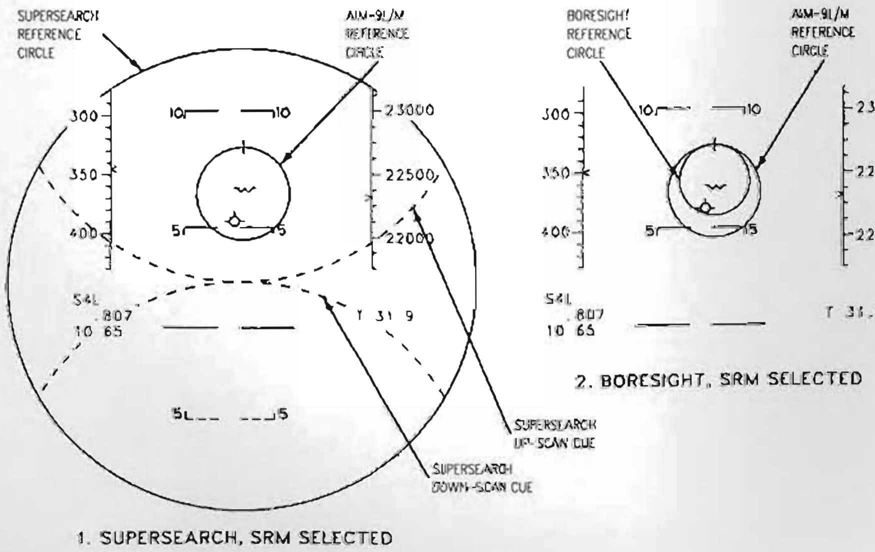
THE RADAR AND HUD

While the CC was effectively the brains of the jet and allowed automation of systems that were formerly operated by the Phantom's weapons systems officer (WSO), the "eyes of the Eagle" was its extremely sophisticated pulse-Doppler radar. Hughes had been awarded the tender to build a radar for the F-X program in 1968. There had been several design options, but the one eventually chosen encompassed the aim of producing an advanced radar with a limited capability against ground targets, an all-weather capability against airborne threats, and provisions for cueing optical tracking systems which may be installed at a later date. Chosen by McAir and approved by the USAF, Hughes received an $82m contract on September 30, 1970 to build what was to become known as the AN/APG-63 radar.

The APG-63 was a coherent PD radar (the signal source remained running all the time and the amplifier was turned on and off to transmit a signal from the antenna) that held numerous advantages over the older Westinghouse APQ-100/109A pulse radar housed in the nose of the F-4C/D. While the Phantom radars used low pulse repetition frequencies (PRFs), the APG-63 employed high PRF (HPRF) to locate and track targets in ground clutter using Doppler shift, and medium PRF (MPRF) to fine tune range data for weapons employment. Thus it could track targets at different ranges, formations, closing speeds and altitudes relative to it. It could also interrogate a contact, using the Hazeltine APX-76 IFF (identification friend or foe) interrogator and Litton reply evaluator, in order to determine if it was friendly or not. Early PD radars had been good in the head-on, look-down environment, but had been weak in tail-on and maneuvering situations. The APG-63 addressed these two weaknesses by automatically interleaving high- and medium-PRFs.[10] Whereas the F-4's radar historically had a 40nm search and 10nm lock on range and could not look down at all, the F-15's system would be able to detect fighter-size targets in a look-up environment at around 80nm, with a look-down capability of about half that. Overall the Eagle's radar search volume was 4.3 times larger than the Phantom's.

For the first time the radar displayed a "clean" synthetic image to the pilot. This meant that the pilot looked not at the raw echoes detected by the radar, but at clear and easily-interpreted symbology on the VSD. This was made possible because the radar was interpreting the unprocessed data through two small computers (with a combined capacity of 24K) of its own. One was a digital signal processor (DSP), the other a radar data processor (RDP).[11] The DSP interpreted the raw radar returns detected by the antenna, and then passed them to the RDP, which determined whether a return was in fact a valid contact. By positioning filters – electronic "blank spots" in the radar's downward coverage – at every combination of azimuth, elevation angle and closure rate that would generate Doppler shift returns close to, or equal to, the ground speed of the F-15, the radar was effectively programmed to "ignore" returns from the ground below. This made the APG-63 "blind" to all ground returns (and any targets at those locations if they were

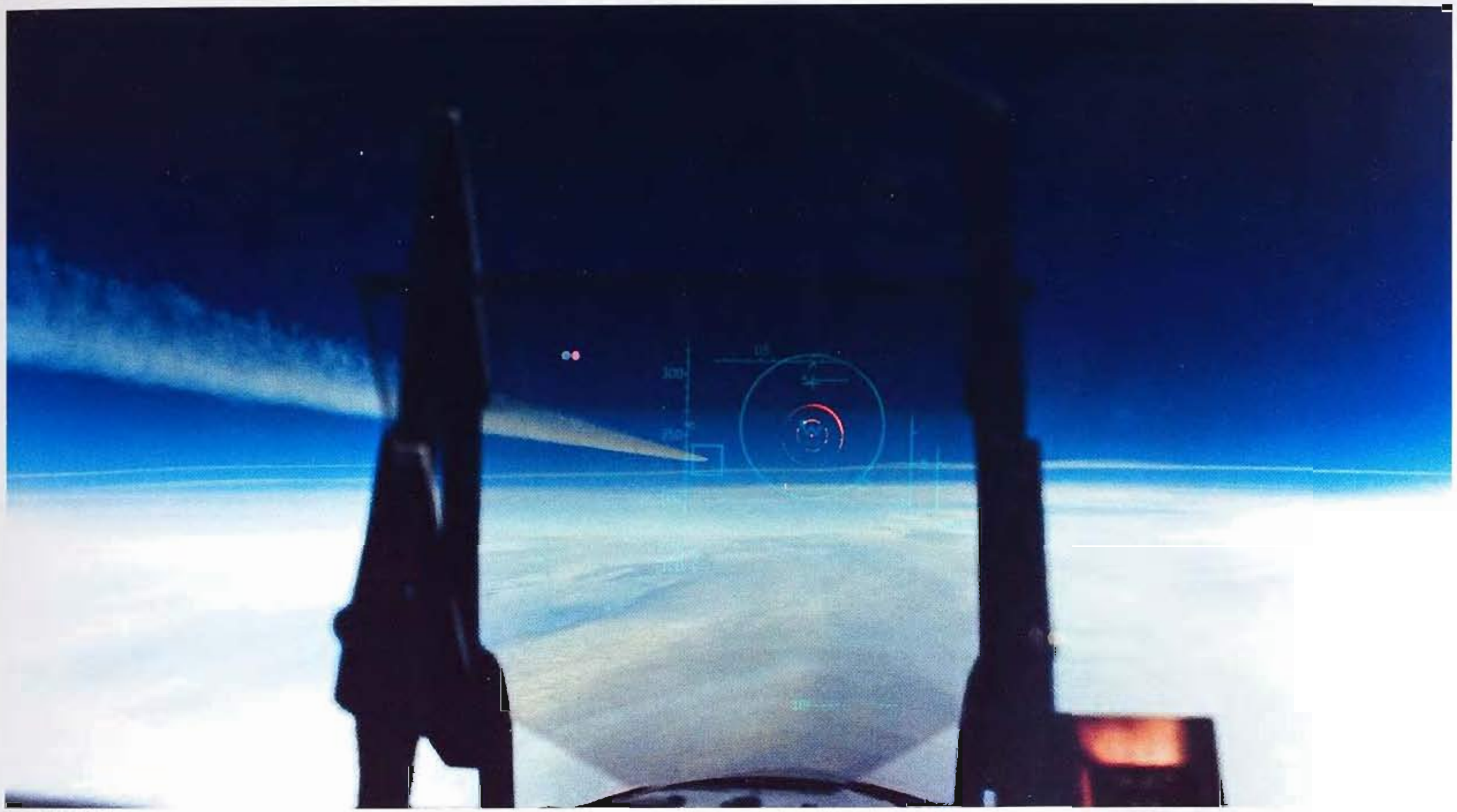
AUTO ACQ MODES. HUD DISPLAYS


SUPERSEARCH REFERENCE CIRCLE
AIM-9L/M REFERENCE CIRCLE
300
350
400
10
10
5
5
23000
22500
22000
54L
.807
10 65
T 31 9
5L
5
SUPERSEARCH UP-SCAN CUE
SUPERSEARCH DOWN-SCAN CUE
BORESIGHT REFERENCE CIRCLE
AIM-9L/M REFERENCE CIRCLE
300
350
400
10
10
5
5
23000
22500
22000
54L
.807
10 65
T 31.9

1. SUPERSEARCH, SRM SELECTED

2. BORESIGHT, SRM SELECTED

LEFT
The radar would enter different scan patterns depending upon the Auto Acq mode selected, but whichever pattern was employed the HUD would provide the Eagle pilot with a visual representation of where the radar was looking. All he had to do was place the target within the scan volume indicated in the HUD. (USAF)



ABOVE
Previously said to depict an AIM-7 en route to its target, this look through an Eagle's HUD actually shows what the wingman sees while doing a high altitude (in the contrails) straight ahead rejoin on his flight leader. On the left is the airspeed scale (360kt), the heading scale is at the top (098 degrees), the altitude scale to the right (33,000ft), and to the far right the DLZ for the AIM-7. The flight leader is very helpfully framed by the target designator (TD) box to the left of the HUD. The red symbology is the back-up gun sight, which is not usually activated unless the HUD experiences a failure of some sort. (Boeing via Steve Davies)

flying perpendicular to the flight path of the F-15, and thus had the same relative motion as the ground beneath the F-15) at the F-15's ground speed, and it effectively eliminated the clutter reflected by the ground thus the radar's computer decided which echoes came from other aircraft. The RDP then built track files, histories of each radar contact that allow the radar to extrapolate the target's changing position when signal loss is experienced, and aid the radar in knowing where to look to reacquire the lost contact. It then passed these track files to the CC, which generated symbology for the VSD to represent the radar contacts.

Whereas fighter pilots of the past – and interceptor pilots, in particular – had spent a long time "heads down" into the cockpit, looking at their radar scopes and doing their best to distinguish contacts from clutter, seeing contacts briefly appear and then disappear as the radar beam swept past them, the pilot could now spend more time heads up, looking outside the aircraft while glancing down to observe track files on the VSD. It made the one man mission concept a reality and, as Larry Walker, an experimental test pilot at McDonnell Douglas, concluded: "has done so much to eliminate the hours of practice required to attain the right radar gains for the salt and pepper effect [the contrast between bright returns where radar energy is reflected back and dark areas where its energy has been dissipated] needed with earlier generation weapon systems."

While the radar eliminated ground returns and provided synthetic symbology for display on the VSD, the CC overlaid the DLZ/WEZ information for the weapon selected and computed a myriad of details useful to the pilot in prosecuting the attack. These included the target's altitude, heading, airspeed, closure rate, aspect angle[12] and *g*-loading.

Vought A-7 Corsair IIs were the first tactical jets to feature a HUD. It presented airspeed, altitude, heading, gun sight and air-to-ground (A/G) weapons release cues by looking directly outside, through the windscreen. The Eagle's HUD went another step further to assist with a visual pick up of the target. To do so, the CC created a target designator (TD) box on the direct line-of-sight through the HUD to the target. The TD box was superimposed over the target and cued the pilot's eyes to his quarry. Further, the F-15 HUD displayed DLZs; weapons steering cues; maximum, optimum and minimum missile launch range indicators; jamming cues from the radar; shoot cues; and a host of other mission-specific data.

HOTAS

By the time Operation *Rolling Thunder* ended in 1968, 22 percent of US fighters being lost in combat over NVN were attributed to MiGs. Consequently, at the very time that design options for the USAF's future air-to-air fighter were being finalized, the Navy

The "Eyes of the Eagle": The Hughes AN/APG-63 Radar

The Hughes AN/APG-63 is a high-frequency, X-band (8-12 GHz) PD radar designed primarily for air-to-air combat. The original APG-63[11] consisted of a planar array (flat faced) antenna, an analogue [sic] processor, digital signal processor, radar data processor, power supply, exciter, transmitter, receiver and radar set control panel in the cockpit. It provided target range, range rate (closure), antenna angles (azimuth and elevation) and angular rates (antenna movement to track the target) to the CC for computation of selected weapon attack parameters. The CC presented the results as synthetic symbology to the pilot on the VSD in "B-Scope" format, which was a top-down view that showed range versus azimuth, with digital information displayed near the target "blip" and along the "range bar" at the edge of the scope. The original "vanilla" APG-63 offered a variety of radar modes broken down into search, acquisition and special modes.

The primary "radar look" was Long Range Search (LRS) which was optimized by using alternating sweeps (interleaved "bars") of high- and medium-PRFs while scanning as far out as 160nm (displayed on 160, 80, 40, and 20nm scopes). Use of both PRFs improved the capability to detect targets in a look-down situation as well as in tail-aspect and maneuvering target acquisition. There was also a Short Range Search (SRS) which used MPRF only, expanded vertical volume and shorter range (10nm scope) to find targets which may have slipped in close or were suddenly "handed off" from another formation member due to a weapons launch failure or higher-priority threat. Velocity Search was a long-range surveillance mode that used HPRF exclusively and presented targets in a closure-versus-azimuth format. It was optimized for early detection of very fast targets such as the MiG-25. Finally, Pulse was originally a low-PRF back up to all air-to-air modes (except SuperSearch), but was useable only in a look-up environment.

There were two types of acquisition mode available: manual and automatic, both of which placed the radar in Single Target Track (STT). In manual mode, the pilot used the Target Designator Control (TDC) under his left middle finger to position the acquisition symbol on the VSD over the target of interest, and then pressed and released the TDC to enter STT.

There were four automatic acquisition (Auto Acq) modes: Auto-Guns, SuperSearch (SS), Boresight (BST), and Vertical Scan (VS), all of which used a 10nm display. The Auto Acq modes would, as the name suggests, automatically lock on to the first target they detected in their scan pattern and were therefore extremely valuable in close-in, visual maneuvering against an enemy fighter. Auto-Guns was commanded by moving the Weapons Select Switch on the side of the throttle aft into GUN; if the radar was not in STT or another Auto Acq mode, it would commissioned Commander Frank Ault (although a bomber pilot with experience in the North American AJ-2 Savage, he was a consummate analyst) to investigate. His team personally visited several fighter units in SEA and interviewed commanders and aircrew. His resulting report highlighted no fewer than 242 reasons why things were going wrong over NVN. Among many other things, Ault's report found it took an average of 5.2 seconds and 12 switch actuations in the cockpit to actually fire a Sparrow missile. By this time the target had usually closed from the point where it had been visually identified (VIDed) as a MiG, to inside the AIM-7's minimum range. Thus the MiGs were being allowed to come to the merge – the point where two fighters pass each other and begin visual maneuvering (or "dogfighting") – with relative impunity, and the short-range, stern-aspect-only AIM-9B Sidewinder heat seeking missiles were almost useless because the Phantom could rarely get behind its more nimble opponent.

Through Ault's report in January 1969, it had become crystal clear that one factor responsible for the Air Force's poor kill ratios was the chaotic cockpit ergonomics of the F-4. This finding was not lost on the cockpit designers at McAir and the 199-B design would eventually benefit from over two years' worth of input from Air Force and McDonnell Douglas pilots, plus the thoughtful concern of ergonomics experts. The F-15 cockpit was thus designed with maximum armament delivery capability in mind and specifically to allow the pilot to look for, detect (and VID through the TD box in the HUD), acquire and fire at an approaching target without ever having to take his hands off the throttle and stick. Hands On Throttle And Stick – HOTAS – was born.

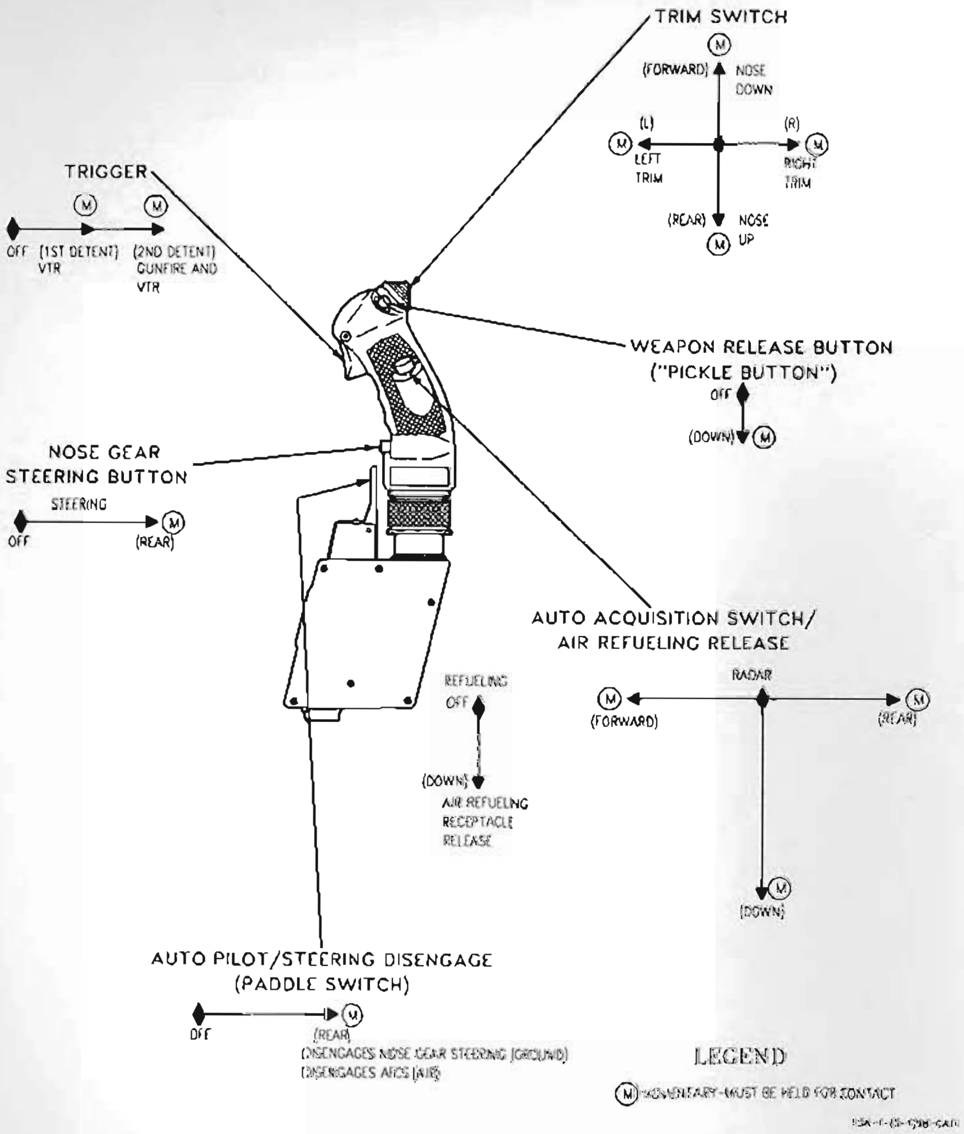
immediately start searching a designated volume of airspace – a 60 degree azimuth and 20 degree elevation scan pattern out to 10nm – which was slewable using the TDC to position the scan somewhere ahead of the aircraft. Sometimes it was preferable to scan in the direction of a turn to get an early lock on a target believed to be in that direction (before having to resort to SRS and acquire the target manually). Other times Auto-Guns was used to scan "outside the turn" (under the nose, or to the "belly side" of the turn) to pick up anyone attempting to attack from the "blind side."

The other Auto Acq modes were used when the pilot was already visual with the target and needed to get the radar on it to employ ordnance (the preferred method of shooting). If the target was visible out ahead, the pilot simply pointed the nose at it, put it in the 20-degree SuperSearch reference circle on the HUD and thumbed forward on the Auto Acq switch to command an SS lock on. If the target was maneuvering against a friendly aircraft and a very discriminating lock on was required in order to ensure the radar locked up the enemy and not the friendly, the pilot double-thumbed forward on the Auto Acq switch to command the radar to enter BST mode, and placed the much tighter (4 degree) circle over the target to lock it up. Finally, if maneuvering against an adversary, VS was used to search vertically (in reference to the aircraft's wings) up and down 5 degrees to 55 degrees above the aircraft's nose to acquire the enemy "across the turning circle."

Special modes included Manual Track, Visual Identification (VI), Beacon, Sniff and Flood. Manual Track allowed the pilot to observe a target detected in a search mode, but used a much tighter scan pattern (3½-bar) that hopefully would not trigger the enemy's EW (electronic warfare) gear. VI mode was the antithesis of this, as it locked-up the contact and then guided the pilot through HUD and VSD displays to fly an intercept profile which ended low and just off the target's wing, facilitating a VID of the target. Beacon was a receive-only mode that allowed vectoring to an aircraft, such as a tanker, or a ground position with an electronic beacon transmitting on a certain frequency. Sniff was a listen-only mode that minimized F-15 radar emissions in order to improve detection of jamming platforms and other airborne radars. Flood provided range-only information out to 2nm by "dumping" the radar antenna (tipping it forwards) and transmitting HPRF using the "flood horn" for firing an AIM-7.

A/G modes were the pulse-only Ground Mapping Mode and the PD Plan Position Indicator (PPI) Ranging mode for determining slant range (up to 10nm) to a ground target. The latter, fed into the CC automatically, resulted in the A/G display on the HUD telling the pilot when to release the A/G weapon.

CONTROL STICK


TRIM SWITCH
(FORWARD) NOSE DOWN
(L) LEFT TRIM
(R) RIGHT TRIM
(REAR) NOSE UP
TRIGGER
OFF
(1ST DETENT) VTR
(2ND DETENT) GUNFIRE AND VTR
WEAPON RELEASE BUTTON ("PICKLE BUTTON")
OFF
(DOWN)
NOSE GEAR STEERING BUTTON
STEERING
OFF
(REAR)
AUTO ACQUISITION SWITCH/ AIR REFUELING RELEASE
RADAR
(FORWARD)
(REAR)
(DOWN)
REFUELING
OFF
(DOWN)
AIR REFUELING RECEPTACLE RELEASE
AUTO PILOT/STEERING DISENGAGE (PADDLE SWITCH)
OFF
(REAR)
DISENGAGES NOSE GEAR STEERING (GROUND)
DISENGAGES AFCS (AIR)
LEGEND
M
MOMENTARY-MUST BE HELD FOR CONTACT

ABOVE
This schematic depicts the first stick grip installed in the Eagle. In later years the Eagle would be upgraded to include a new grip and throttles with even greater HOTAS functionality. (USAF)

By having all the necessary switches and buttons on the throttles and stick, immediately under the finger or thumb used to actuate them, there was no requirement to look down into the cockpit. Thus HOTAS comprised a collection of switches and buttons that controlled the Eagle's radar, weapons systems and, later, the self-defense countermeasures dispensers (CMDs). The controlling switch was the Weapons Selection Switch, located under the left thumb (on the inboard side of the No. 2 throttle), below the microphone, EWWS (Electronic Warning Warfare Set) and speed brake switches. There were three settings: MRM (AIM-7 missile selected and LRS on the radar), SRM (AIM-9 selected and SRS on the radar) and GUN (M61A1 gun selected and Auto-Guns for the radar if no lock on already). Thus this switch dictated not only which weapon was being selected, but also it controlled the radar through two manual and one auto settings, and thus enabled other switches on the throttles and stick.

On the front facia of the inboard (No. 2) throttle under the left middle finger was the TDC to manually control the acquisition symbols on the radar in LRS and SRS and slew the Auto-Guns search volume in GUN. Beside it was a button which interrogated IFF (identification friend or foe) equipment (all modes whether in search or track) and, in SRM, boresighted the AIM-9L/M (once it was added to the weapons mix). The outboard (No. 1) throttle carried the gun sight reticule stiffen (button) for short-range, no lock on "snapshots" under the left ring finger and the radar antenna elevation rotary wheel under the "pinkie finger." Later, on the outboard side of the throttle the CMD activation switch was added, to be hit by the edge of the hand "karate-style" whenever chaff and flares were needed to spoil an enemy shot.

On the stick, the primary switch – Auto Acquisition – was under the right thumb. No matter which search mode was employed (with no lock on) pushing forward once selected Super Search (SS) and twice gave Boresight (BST) to lock up a target visible in the HUD. Pulling it back sent the radar into Vertical Scan (VS) and pushing down on it sent the radar into Return to Search (RTS), giving it back to the search mode commanded by the Weapons Select Switch (MRM, SRM or GUN). When the radar was off and the aircraft was air-to-air-refueling (AAR) this switch released the boom from the

AAR receptacle. On the forward side of the switch was the nose wheel steering button which, on the ground, did just what its name says. However, when the gear was up and SRM was selected, it uncaged the AIM-9L/M seeker head to confirm a "self-track" before shooting. Atop the switch was the USAF-standard trim button, gun trigger[14] and weapons release, or "pickle," button. Whichever weapon was selected (MRM, SRM, or specific A/G ordnance), it was released with the push of this button if the Master Arm Switch was in ARM.

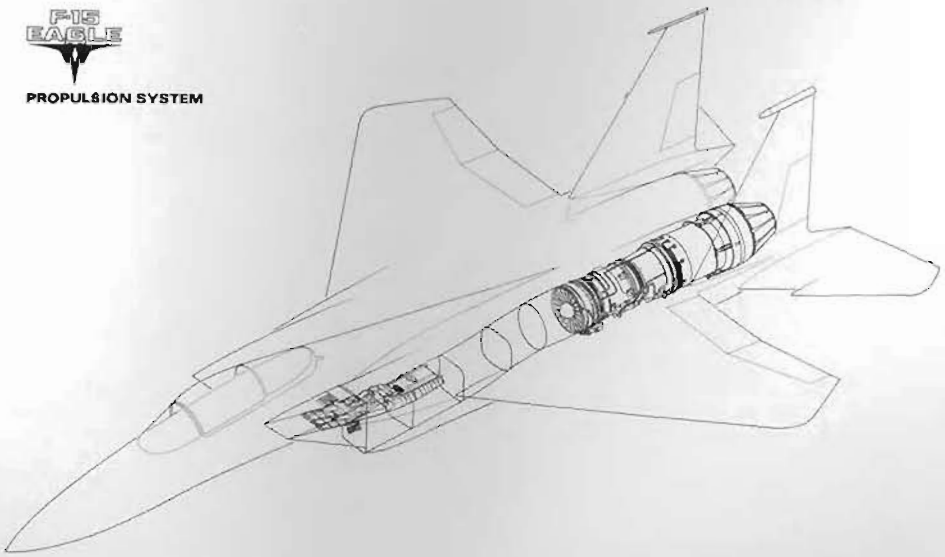
While involved, the various switch actuations needed to lock up the enemy target and fire the most appropriate weapon soon became second nature, as in learning to play the piano, knowing through practice just which switch was under each finger. However, in the heat of battle, many of the manipulations were required to be accomplished in such a "rapid-fire" manner that the flurry of finger motions was sometimes known as "playing the piccolo." A good piccolo player made for a deadly Eagle Driver.

MOTORS

On February 27, 1970, a $448m contract was awarded to P&W to produce the "common compressor/turbine core" afterburning turbofan going by the cumbersome and confused DoD-directed name of Advanced Turbine Engine Gas Generator (ATEGG). The proposed ATEGG had its roots in three engines already produced by P&W: the TF30-P-1 for the F-111, the TF30-P-412 for the F-14A and the J58 for the SR-71. P&W planned to accommodate the differing needs of the USN and USAF by building a "standard core" but substituting larger fans, fan ducting and a different afterburner to provide the increased thrust required by the Navy.[15] The contract called for P&W to produce 90 F100-PW-100 (USAF designation) and F401-PW-400 (USN designation) engines for test and evaluation. A Joint Engine Project Office (JEPO) was established to iron out the differences that naturally arose as a result of the Navy having requirements of the engine that differed from those of the Air Force.

The charade of "jointness" did not last long; soon the USN again went its own way. According to James P. Stevenson, who extensively researched the Grumman F-14A Tomcat and wrote *McDonnell Douglas F-15 Eagle* (Aero Publishers, 1978), the Navy had run into funding problems in other programs and since it already had a fully developed airplane with a mature engine (F-14A with the TF30-P-412), it siphoned money from the ATEGG account. As it did, the Navy reduced its proposed F401 order, in stages, down to only 58 engines before finally, in June 1971, canceling its order altogether, deciding instead to make more F-14As and continue using the TF-30. Project costs escalated – caused mostly by the more complex development cycle for the Navy version of the engine – and as the Navy backed out of the program these had to be borne by the USAF. It cost the Air Force $110m for the Navy to leave the program.

The engine was to be developed under the DoD's milestone concept. Under this program the F100 would have to meet eight milestones (MS) and each would have to be successfully passed for funding to be awarded for further development. The two most significant milestones were the preliminary flight rating tests



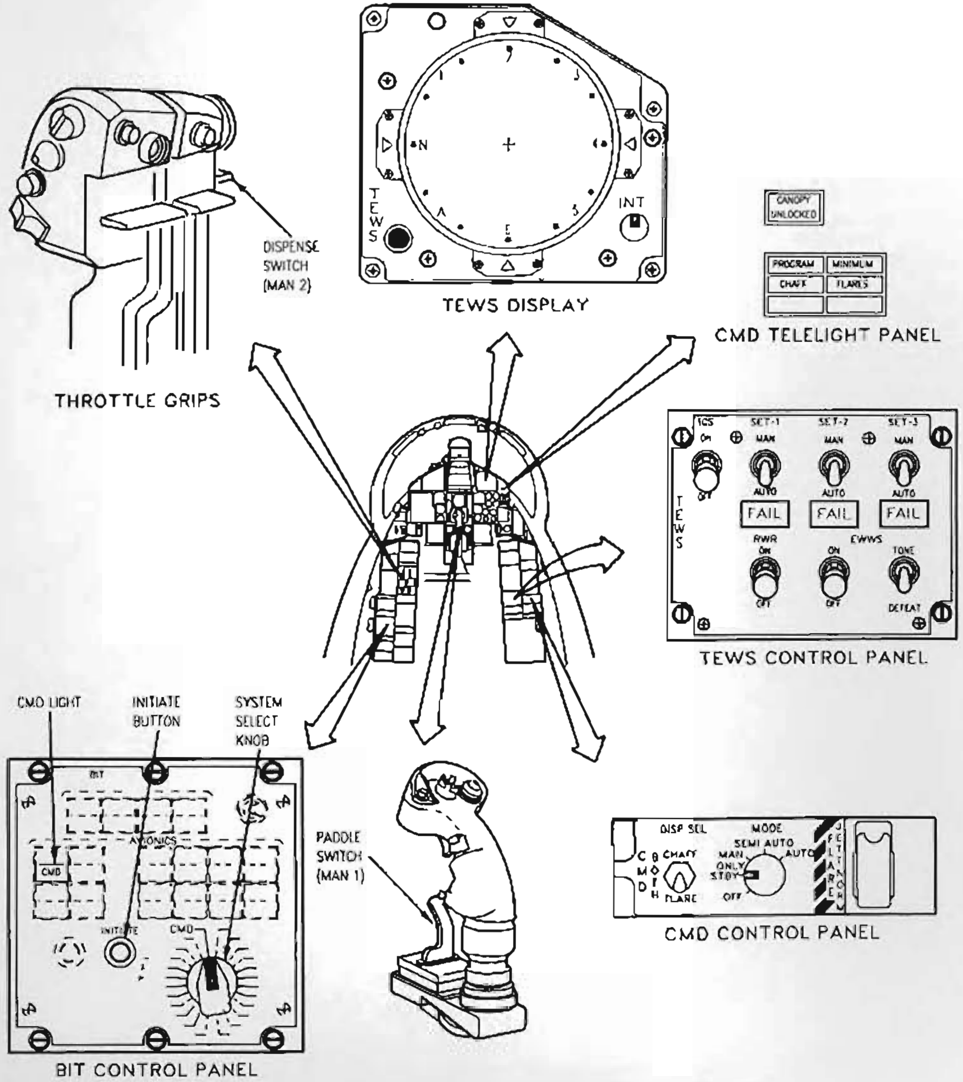
BELOW
The Eagle's motors sit well toward the rear of the aircraft, behind a very sophisticated air inlet system that consists of an array of ramps that move to maintain subsonic airflow to the engine compressor face regardless of the speed at which the aircraft is traveling. (Boeing via Steve Davies)

(MS6) set for March 31, 1972 and the endurance qualification test one year later. By February 1972 the prototype F100 was running and had completed 60 hours of testing and passed MS6 ahead of schedule, allowing the Eagle's flight test program to begin. However, the DoD noted that problems existed, primarily with the compressor section's efficiency. It approved the first production F100s (actually prototype motors designated YF100 Series I) on the condition that the engine meet its 150-hour endurance qualification test by May 1973.

With the specific requirements of the USN now out of the way, the F100 obtained an advanced aerodynamic compressor that had been too heavy for the Navy's requirements. The advanced compressor redressed performance problems and deficiencies that had plagued the "standard" compressor section and had contributed to delaying the completion of the 150-hour endurance qualification test.

The production F100-PW-100 would lead a troubled life from start to finish and it would be only in the years ahead, as improved versions of the F100 (PW-220 and PW-220E) became available, that the Eagle would start to offer the carefree throttle movements that a pilot in combat required.

CMD CONTROLS, INDICATORS & DISPLAYS


DISPENSE SWITCH (MAN 2)
THROTTLE GRIPS
TEWS DISPLAY
INT
CANOPY UNLOCKED
PROGRAM
MINIMUM
CHAFF
FLARES
CMD TELELIGHT PANEL
TEWS
ICS
SET-1
SET-2
SET-3
MAN
AUTO
FAIL
RWR
EWWS
ON
OFF
TONE
DEFEAT
TEWS CONTROL PANEL
CMD LIGHT
INITIATE BUTTON
SYSTEM SELECT KNOB
BIT
AVIONICS
CMD
INITIATE
BIT CONTROL PANEL
PADDLE SWITCH (MAN 1)
DISP SEL
MODE
SEMI AUTO
MAN
AUTO
ONLY
STBY
OFF
CHAFF
FLARE
CMD
FLARE
CMD CONTROL PANEL

TEWS

Tactical Electronic Warfare Suite (TEWS) was the title given to the complete defensive aids system that would be installed in the Eagle. TEWS represented a leap in capability because of the manner in which all (eventually) of its four main components shared information and resources, but it was also unique in that it would be the first integrated and almost completely independent and automatic system of its kind installed in a fighter. Of the four main components, the Loral ALR-56A radar warning receiver (RWR) warned the pilot of surface (SAM or AAA) and airborne (other fighters) radar threats looking at his aircraft. The Northrop ALQ-135 Internal Countermeasures Set (ICS) automatically jammed these threats. The Tracor ALE-40/45 Countermeasures Dispenser (CMD) was added later (with MSIP, the Multi-Stage Improvement Program) to provide active means of defeating a "missile in the air." The fourth component was the radar itself.

LEFT
The CMD was interfaced via the throttles and stick grip and could be programmed to activate automatically, semi-automatically or manually. (USAF)

"EARS OF THE EAGLE": TEWS

Component	Manufacturer	Description
AN/ALQ-135	Northrop	Internal Countermeasures Set (ICS)
AN/ALR-56A	Loral	Radar Warning Receiver (RWR)
AN/ALE-40/45 (with MSIP Modifications)	Tracor	Countermeasures Dispenser (CMD)
AN/APG-63	Hughes	Radar

The Northrop ALQ-135 ICS offers active electronic protection in the form of deception and noise jamming. The ALQ-135 is designed to counter a range of SAM and AAA systems and selected airborne threats, such as the MiG-25's "Fox Fire" airborne intercept (AI) radar. Key to its long-term utility is its capacity for re-programming, allowing software updates in response to changing threat parameters and mission requirements. This Pre-Flight Message threat library is software coded and uploaded into the ICS LRUs.

The ALQ-135 covers the three frequency bands H, I and J in the 6-20 Ghz range and shares its high-band antennas with the RWR, mounted at four locations on the airframe; two on the wing tips, two rear-facing at the top of the vertical stabilizers and one beneath the forward fuselage, all of them time shared between the two systems. A preamplifier boosts incoming signals prior to them being sent to the CC for analysis, prioritization and interference analysis. ALQ-135 Control Oscillator boxes and software then create jamming routines and send them to the radio frequency (RF) amplifier. These boosted jamming signals are then transmitted back toward the threat emitter via two wing-root mounted forward antennas, or the rear right tail boom mounted antenna. ICS status indications are provided on the TEWS display in the cockpit.

The Loral AN/ALR-56A (and the later, digital "C" version) RWR provides threat emitter location and identification via the TEWS scope in the cockpit, giving approximate azimuth and distance from the threat. Audio tones serve as aural cues at times when the pilot is busy heads-up and unable to consult the display. The RWR comprises a power supply, an analog system computer, a signal processor which measures the parameters of incoming signals, and the antennas it shares with the ICS. A software library provides the RWR with its threat library and response logic. The ICS was not installed in the Eagle until 1977.

The Magnavox AN/ALQ-128 Electronic Warning Warfare Set (EWWS) falls outside of the TEWS "family," but is nonetheless an important EW system which covers frequencies outside those detected by the RWR. The EWWS is derived from the APX-80 *Combat Tree* of SEA[16] and consists of a left sector antenna; a right sector antenna (both flush mounted forward and slightly below the cockpit windshield); rear sector antenna (pod mounted on the top of the left vertical stabilizer); fire control radar dipole antennas (attached to the radar dish); a diplexer assembly; a receiver/transmitter; and an electronic video switch. A guarded "enable" switch in the cockpit prevents inadvertent use of this classified system.

While the RWR would be the most important component to the pilot because it informed him of threats and allowed him to maneuver his aircraft to help counter, defeat, or kill them, the ICS working silently "behind the scenes" was truly the most significant part of the TEWS system. The ICS "jamming boxes" were located in the expansive Bay 5[17] behind the pilot's ejection seat. Whereas USAF fighters in SEA had to carry externally mounted electronic countermeasures (ECM), the F-15A would carry a much more sophisticated system internally.[18] Bay 5 also provided a convenient position in which to mount the second seat for the F-15 trainer, initially designated TF-15A. The TF-15 was a fully combat capable version of the basic airframe, losing no fuel or internal gun ammunition capacity (as the F-16B did) to the second seat. For its electronic self-protection, the TF-15A would mount a Westinghouse ALQ-119 ECM pod on Station 1 or 9, between the wing pylons and wingtips (it was the only external store which could be mounted there), or on the centerline station (No. 5) with no loss of combat potential.[19] Because of this fact, the USAF redesignated all TF-15As as F-15Bs on December 1, 1977.

For the F-15A the TEWS would provide a holistic EW capability that was largely automated and required little user input to function properly. From the outset, TEWS was developed to allow communication between the four subsystems. The RWR and ICS would share data between themselves and the radar. If the ICS detected a threat, it could commence the appropriate jamming routine, inform the radar of this (so that radar desensitization [making the radar less sensitive to jamming] could be initiated), and inform the RWR so that it too could factor own-ship emissions into its analysis of the electromagnetic spectrum surrounding the jet. Similarly, if the RWR detected a threat before the ICS, it too could initiate jamming. Finally, if the RWR or ICS were "slow" to detect a threat, the radar could pass detected radar activity to either subsystem. An interference blanker system was provided to allow each subcomponent to operate with minimal impact on the performance of another. Gary Jennings, a McAir test pilot, recalled

BELOW
The SPO's "Not a Pound for Air to Ground" slogan was one that would reverberate through future generations of Eagle pilots to follow. Indeed, aside from some very low-key and limited scope air-to-ground continuation training in the Eagle's very early days, USAF pilots in the three decades that followed would employ the jet exclusively in the air-to-air arena. (Steve Davies: www.fjphotography.com)

that this blanker system was extremely effective: "the F-15 has always done a good job of making sure that the aircraft's transmitters have had minimal impact on the radar's performance."[20] Calibration was also used to prevent the RWR/ICS antennas from processing ICS transmitted pulses.

What this meant was that the Eagle pilot could leave the TEWS suite to its own devices and concentrate on attacking or defending against an enemy airborne or ground target. Once again, the TEWS was a critical device built with a one man cockpit in mind.

AIR-TO-AIR VS AIR-TO-GROUND – COMPETING INFLUENCES

With the ultimate objective of designing an aircraft whose avionics were to be optimized for air superiority, and with the SPO's catchy slogan "Not a Pound for Air-to-Ground" ringing in their ears, the F-15 engineering design team faced the unenviable task of creating a suite of avionics that left the Eagle's air-to-air potential uncompromised, but also met basic air-to-ground specifications. The problem was a complex one primarily because there was a palpable fear of – and an equally tangible resistance to – allowing Model 199-B to balloon in weight. Were it to prove to be the case that fulfilling both air-to-air and air-to-ground obligations meant installing black boxes, or LRUs, that served only one mission or the other, then this was a very real possibility. "Maximum power and maneuvering capability with minimum weight and complexity,"[21] were assets of the Eagle that simply could not be compromised, wrote a reflective Don Stuck, Advanced Design Project Engineer, in 1975.

Stuck, wearing what one can only imagine to have been a trace of a smile, elucidated: "Every time the multi-mission 'attackers' stormed the Project Design castle with features to enhance air-to-ground or other capabilities, the air superiority 'defenders' met and repulsed them." The solution was simple. The air-to-ground troops sold the concept of "helping" the air-to-air advocates with the design of their hardware, with the goal of producing software code and LRUs that could be used for both missions without adversely affecting the primary mission. The theory was simple, but making it happen involved, "an extraordinary amount of time, coordination and gnashing of teeth," recalled Stuck.

The Eagle's power and superb aerodynamics permitted the carriage of some 15,000lb of ordnance on 18 stations littered about the airframe and wings. Not only that, but this could be achieved without removing air-to-air weaponry from the underwing pylons. With the APG-63 radar, CC, VSD and HUD working in unison, it would also be able to maximize accuracy against ground targets. Moreover, the Eagle would be wired to support the latest generation of guided air-to-ground bombs and missiles, without losing any air-to-air weapons or avionics capability.

USAF

03

TEST & EVALUATION

THE FIRST EAGLE

F-15A-1-MC, tail number 71-0280, rolled out of McAir's St. Louis plant on June 26, 1972. Even as more than 1,000 government dignitaries, and too many McAir employees to count, watched General William Momyer, CinC TAC, and McDonnell Douglas Chairman, "Sandy" McDonnell, push forward a set of Eagle throttles to symbolize the rollout of the first F-15, Eagles number 2 and 3 were being fabricated adjacent to the F-4E final assembly line nearby.

Testing was broken down into three phases, or categories: Category I, Contractor Development Test & Evaluation (CDT&E), received 12 aircraft (71-0280 to -0291); Category II, Air Force Development Test & Evaluation (AFDT&E), with eight aircraft (72-0113 to -0120); and Category III, Follow-on Operational Test & Evaluation (FOT&E). The last mentioned was conducted by pilots from TAC's 422nd Fighter Weapons Squadron (FWS; now Test and Evaluation Squadron, or TES), part of the 57th Fighter Weapons Wing (FWW), initially based at Luke AFB, Arizona, using seven aircraft (from the FY1973 batch 73-0085 to -0114).[1]

Category I and II testing were conducted at Edwards AFB, California, by the F-15 Joint Test Force (JTF)[2] which was made up of McDonnell Douglas and USAF test pilots, maintenance and support personnel. The JTF director was Col Wendell Shawler who led a cadre of 11 McDonnell Douglas and ten USAF test pilots. The USAF pilots were from Air Force Systems Command's (AFSC's) 6512th Test Squadron, 6510th Test Wing, stationed at Edwards AFB. The team from McAir were highly experienced and between them had amassed an impressive 81 man years of experience in experimental test flying, some of them having been responsible for flying full scale development (FSD) on three or four different types. These were the men who would first put the Eagle through its paces.

As director of the JTF, Shawler reported to several commands: AFSC, TAC, AFLC (AF Logistics Command) and ATC (Air Training Command). It was his job to monitor the contractor's ongoing progress and report it to HQ USAF and the commands, as well as take the inputs from these commands and communicate them to McAir for integration into the jet.

CATEGORY I CDT&E TESTING

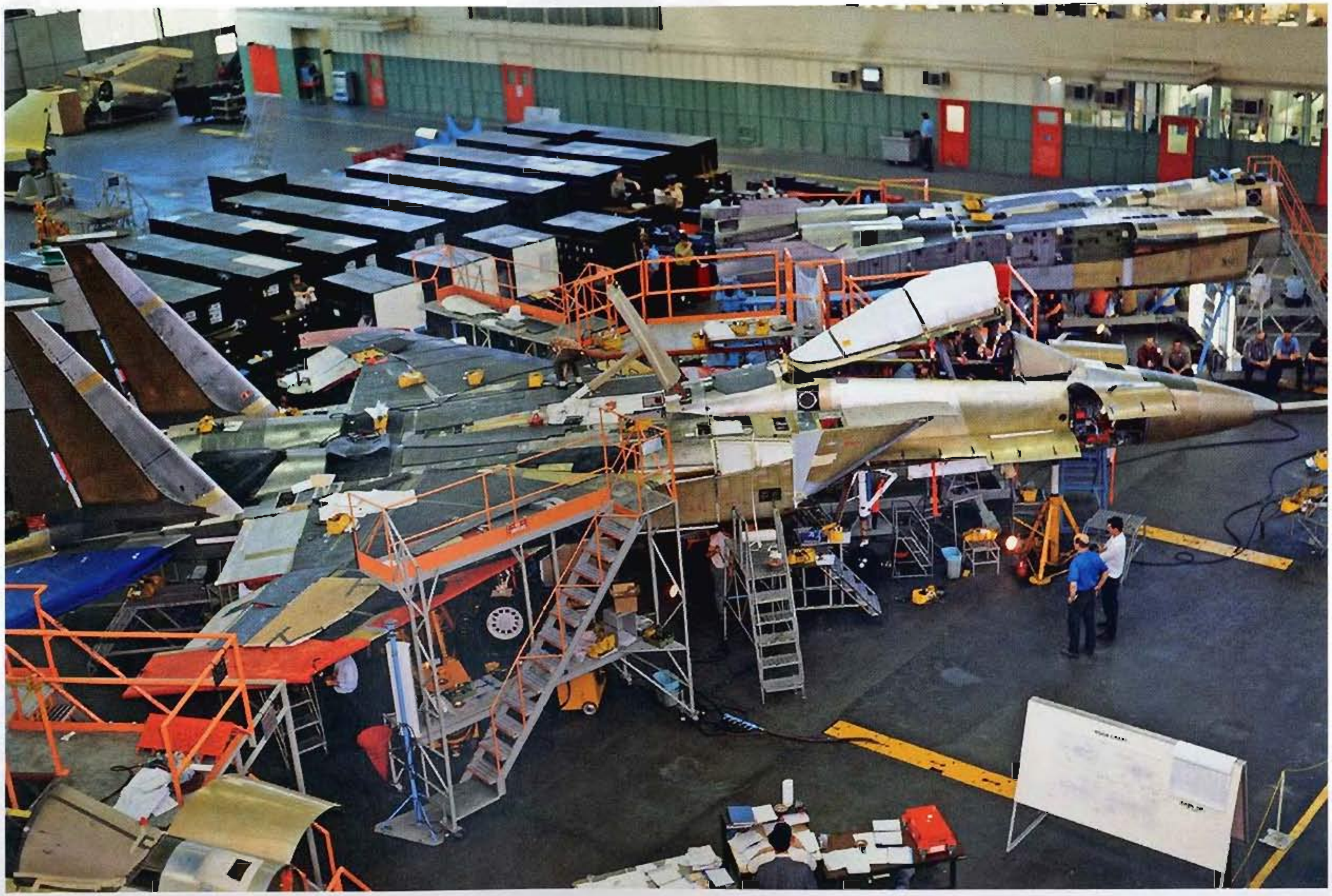
Shipped to Edwards in a Lockheed C-5 Galaxy, '280 – also known as F-1 – made its first flight wearing high-conspicuity Day-Glo orange and white markings a month later on July 27, remaining airborne for 50 minutes with McAir's test pilot, Irving L. Burrows, at the controls. Within a week F-1 had already made another four flights, Burrows taking it to Mach 1.5 and to 45,000 feet. Two months later and with another 40 hours of flying logged, milestones of Mach 2.3 and an altitude of 60,000 feet had been reached.

OPPOSITE
This McDonnell Douglas artist's concept shows how the finished F-X article would look. (Boeing via Steve Davies)

Burrows' first flight had been uneventful, save for an undercarriage door problem that persisted for a couple more flights and delayed the Eagle's first foray into supersonic flight. Burrows had been planning the first flight for more than six months, ever since Joe Dobronski noticed he was experiencing mild dizzy spells and deferred the honor of this maiden flight to him. His preparations consisted of many hours of simulator flights and he maintained currency by flying F-104, A-4, T-38 and F-4 fast jets in the meantime.[1]

His early impressions of the Eagle were very favorable. He'd described the slatted F-4E as the "best yet" the year before he took the F-15 to the skies for the first time, and it was quickly evident that the Eagle would be far superior to the F-4E in every respect. He stated that the jet "felt like a fighter," and was light to the touch and

BELOW
Pictured in April 1972, 71-0280 nears completion. The fuselage of 70-0281 awaits the mating of its forward fuselage, and wing and tail assemblies. (Boeing via Steve Davies)



very responsive. Moreover, he wrote, "Maneuvering qualities are in excess of anything ordered by our customer. It's a genuine pleasure to suck the Eagle into a turn that leaves any chase airplane staggering around unable to hold either the *g* or the speed."[4] As if this were not enough, the Eagle was fast establishing itself, even at this early stage, as an aircraft of reliability. Each test aircraft was averaging something in the region of an "outstanding" 15 flights per month, whereas the F-4 Phantom II had averaged eight over the course of its flight test history.

Burrows also assessed that the F-15 flew "just like the simulator." This must have been music to the ears of Bob Little, a McAir test pilot who had recognized the value of using flight simulators to validate and demonstrate complete aircraft systems to customers before an aircraft had even been built. Indeed, it was Little who had secured $350,000 (FY1969 dollars) from "Sandy" McDonnell to build McAir's first simulator in 1969. Fifteen years later, Little said: "George Graff and I had been sizing-up what we needed to do to win the FX [sic] program. We agreed that McAir had to come up with the most advanced air-to-air combat flight simulation facility available anywhere. We had to invent a 'grabber' and we had to do it right."[5] In doing so, Graff and Little created a product that McDonnell Douglas later claimed "was used successfully to win the US Air Force's F-15 program."

In a 1973 edition of *McDonnell Douglas's Product Support Digest*, a restricted distribution document provided to its customers, Irv Burrows gave details of the CDT&E program at Edwards: "Our number 1 airplane has carried most of the stability and control and handling qualities work. We used it to get our initial look at engine characteristics, and to expand the speed/altitude/*g* envelope. We examined (and are still examining) such things as buffet levels at increasing AoA [angle of attack]; stick forces during maneuvering; adverse or proverse yaw; pitch transients with gear, speed brake and flap extension/retraction; external tank handling characteristics; etc. We are currently clearing the flutter envelope (assuring that none of the control surfaces will tend to vibrate to destruction at any speed/altitude

BELOW
F-1 (71-0280), with Irv Burrows at the controls, taxis towards an expectant crowd at McAir's St. Louis plant in June 1972 following taxi trials. A month later the aircraft was shipped to Edwards AFB and undertook its maiden flight. (Boeing via Steve Davies)

USAF
10280
F-15

BELOW
F-1, in the foreground, is flanked by six other Cat I Eagles on the hot Edwards ramp. Photographed less than a year after Burrows took the Eagle aloft for the first time, the sun-faded Day-Glo panels on F-1's wings betray the intensity of the evaluation process. (Boeing via Steve Davies)

point within the advertised envelope)."[6] Burrows concluded that in nine months F-1 had been flown in the region of 200 times.

One of the most pleasantly surprising attributes discovered during Category I testing was the harmony of the flight controls. The secret lay beneath the new fighter's skin. In addition to the conventional hydro-mechanical flight control system, consisting of rods and pulleys which connected directly to hydraulic actuators attached to the ailerons and horizontal stabilizers and twin rudders, a control augmentation system (CAS) cleverly provided additional subtle control inputs.

The hydro-mechanical system worked through a longitudinal "pitch ratio" and a lateral "roll ratio" to compensate for factors such as altitude and airspeed, to provide protection from adverse yaw and excessive rates of roll at supersonic speeds. Longitudinal stick movements (pilot commands to raise or lower the aircraft's nose) were processed through a ratio of gears that elicited a constant pitch response from the jet for a given movement of the control stick, regardless of the airspeed being flown. Additionally, the pitch-trim compensator (PTC) kept the aircraft trimmed to 1-g flight and would very precisely and rapidly drive the stabilators (all-moving tailplanes) without the pilot noticing. This was a useful feature which obviated the need to trim the jet when accelerating, decelerating, deploying flaps, extending speed brake, jettisoning fuel tanks or firing heavy missiles. If required, mechanical trim could be applied by the pilot through a small "coolie hat"-shaped switch mounted atop the control stick.

The CAS was a dual-channel, three-axis (pitch, roll and yaw) system that took electrical signals generated by a stick force sensor mounted at the base of the pilot's control stick grip, and rudder pedal movement, and translated these into control surface deflections.[7] It offered the advantage of dampening out small stick movements caused by turbulence or other atmospheric phenomena, and also provided better control authority and stability at high AoA. Burrows recounted that there was some heated debate about whether the first flight should be conducted with the CAS turned on or off, and that the doubters were concerned that the stability system – so far tested only on computers – could cause the one and only Eagle to crash. In the end CAS was used without any ill effects.[8]

The CAS immediately proved both its effectiveness and the immense importance of the redundancy it provides, when Pat Henry, one of the McAir test pilots, took to the sky and heard a loud thump. The sortie's intention was to test CAS-off handling qualities, and Henry, unable to establish the cause or effect of the thump, switched off the CAS to discover that he had absolutely no pitch authority. He re-engaged the pitch CAS, whereupon pitch authority was restored. Continuing with the scheduled test sortie as best he could, it was only following inspection of the flight controls upon landing that it was learned that the mechanical pitch controls had failed. No one needed reminding that such a failure in any fighter prior to the F-15 would have resulted in loss of the aircraft, but the CAS had permitted the machine to continue to fly without the pilot noticing any difference.

Two months after F-1 took to the air Eagle Number 2 (71-0281 or F-2) flew for the first time. It was used as a "propulsion development vehicle," while "engine transients are examined under all conditions, as are A/B afterburner lights and shut-downs," reported Burrows.[9] There were two series of YF100-PW-100 engines available to the test force, but early on in the CDT&E cycle this was the only aircraft to feature Series II YF100s capable of producing rated thrust. Additional Eagles arrived at the CTF at two-month intervals, with F-7 (71-0286) being the first to be flown non-stop from St. Louis to Edwards AFB, by McAir test pilot Jack Knights on June 29, 1973. The eighth Eagle off the preproduction assembly line was the first TF-15A, known as TF-1 and was delivered only nine days later. The specific areas evaluated by these and the additional three F-15As and one more TF-15A, are outlined on page 41.

Overall, the test flying by the team from McAir went very well. They had between them what amounted to an aggregate flight time of 30,000 hours, including 12,000 in McDonnell products, the F-4 Phantom II and F-101 Voodoo. They were confident that they were doing a good job in their tests and evaluations. So it came as some surprise when AFSC conducted no-notice inspections of their operations, subjecting them to the same standardization and evaluation (Stan/Eval) tests that squadron pilots in the USAF endured annually. These written exams and flight evaluations put out of joint the noses of the experienced cadre of test pilots, and they even briefly sought legal advice on the

CATEGORY I EAGLES[10]

Serial	Block	Eagle	First Flight	CDT&E Role	Later Dispositions[11]
71-0280	1	F-1	July 27, 1972	Flight envelope and handling qualities, external stores tests.	To 6512th Test Sqn (TES) in 1975; last flight 1979; to Lackland AFB as static display (marked "EG"/85-114) in USAF History and Traditions Museum for basic airman indoctrination.
71-0281	1	F-2	September 26, 1972	Primary engine test airframe.	To 6512th TS in December 1974; NASA 1975–83; to Langley AFB as gate guardian in September 1984.
71-0282	2	F-3	November 4, 1972	No. 1 avionics test bed, first with APG-63 radar, calibrated airspeed tests.	To 6512th TS 1973–77; AMARC 1977–79; to 2955th CLSS, Warner-Robins Air Logistics Center, Robins AFB 1979–86.
71-0283	2	F-4	January 13, 1973	Structural integrity tests.	To 6512th TS in May 1973; McAir 1978–98; displayed at Defense Supply Center, Richmond, VA.
71-0284	2	F-5	March 7, 1973	No. 1 armament test bed, first with M61 gun, external fuel tank jettison tests.	To 6512th TS in October 1975; rebuilt as GF-15 ground trainer, assigned to 82nd Training Wing (TW), Sheppard/17th TW, Goodfellow AFBs, TX.
71-0285	3	F-6	May 23, 1973	No. 1 avionics test bed, missile fire control tests and flight control tests.	To 6512th TS 1973–81; displayed at AF Personnel Recruiting Office, St. Louis, MO, 1982–84; McAir 1984–92; displayed at Lambert Field.
71-0286	3	F-7	June 14, 1973	No. 2 armament test bed, external fuel tank tests.	To 6512th TS in 1973; rebuilt as GF-15; assigned to 3330th TTC, Chanute AFB, IL, 1982–90; displayed at Octave Aerospace Museum, Rantoul, IL.
71-0287	4	F-8	August 25, 1973	High angle of attack and spin tests, fuel system tests.	To 6512th TS in 1973; to NASA January 1976; registered as N835NA November 1986; actively flying.
71-0288	4	F-9	October 2, 1973[12]	Aircraft/engine performance tests.	To 6512th TS 1973 until 1982; current status unknown.
71-0289	4	F-10	January 16, 1974	TEWS, radar and avionics tests.	To 3247th TS 1974 until 1990; reassigned 586th TS/46th TW, Holloman AFB, NM, actively flying.
71-0290	3	TF-1	July 7, 1973	No. 1 Two-Seat Stability, Control and Performance Tests.	To 6512th TS 1973 until 1979; AFSC in 1980; McAir in 1984; STOL/Maneuver Technology Demonstrator September 1989; to NASA as N837NA December 1994; actively flying.
71-0291	4	TF-2	October 18, 1973	No. 2 Two-seat stability, control and performance tests.	To 6512th TS in 1974; McAir September 1976 for numerous FMS sales promotions; F-15E Strike Eagle test bed, first flight July 8, 1980; currently airframe battle damage repair (ABDR) trainer, Robins AFB, GA.

feasibility of forming a union that would protect them from such unwanted and, as they saw it, unwarranted attention. In the end the idea was dropped, and the close-knit team of test pilots accepted that although the Navy had never treated them so patronizingly, the Air Force had good reasons for wanting to standardize this large-scale operation. Perhaps this was due to the political scrutiny the USAF's F-15 program was getting from Washington, DC.

THE F-15 PROGRAM AS A POLITICAL FOOTBALL

While flying continued unabated at Edwards, DoD officials of the Republican (Nixon) administration in Washington and, more specifically, USAF officers in the Pentagon, were having to fend off ever increasing media speculation about the cost of the Eagle program, and the manner in which the Air Force's projected costs were being calculated. While the USAF was eager to vocalize its optimism that the total program cost would hold at $7.835 billion for 729 operational Eagles, it was less keen on admitting that certain F-15 project costs were being withheld from the accounting sheets that were required under new laws passed by Congress. Thus, the General Accounting Office estimated in March 1973 that the Eagle program was actually $1 billion over budget, primarily because of problems developing the F100-PW-100, but also because of issues associated with manufacturing spares and specialized ground support equipment.

There was some creative accounting going on too, claimed the press. The Air Force was not including the cost of the APG-63 in the budget and for some peculiar reason it was including only one-quarter of the total cost of the Eagle's navigation equipment. It was with some embarrassment that the Air Force announced the same month that the F-15 program would slip slightly because of the F100-PW-100's problems. At the same time the Air Force missed the opportunity to correct a press report citing a secret Pentagon report that rather than the three engine failures so far declared to the public, the engine had been the victim of a jaw-dropping 52. Les Aspin, the new Democrat congressman for Wisconsin, accused the Pentagon of "monkeying around" with the figures, and of "book juggling," when he claimed that the Air Force had cut the cost of the Eagle program by $491m when it learned the F100-PW-100 cost had gone up to $493m! Aspin was equally incensed that the USAF also failed to include the costs of the M61A1 Vulcan cannon on the grounds that it was being used on other aircraft.[13] Of course, as the man heading the Eagle program for the Air Force, BrigGen Bellis had to field this often-fierce criticism with cautious optimism.[14]

The enhanced serviceability and reliability of the Eagle saw the completion of five Air Force Preliminary Evaluations (AFPEs) by October 31, 1973, using the 11 F-15s available for testing by that time. In all, the Eagle had so far amassed 1,010 flight hours; exceeded Mach 2.5; flown a maximum calibrated airspeed of 800 knots, a minimum non-stalled airspeed of 104 knots, and a maximum altitude of 66,900 feet; and pulled to 6.3 *g*s, which was the design *g* limit at that time. The Eagle's 1,000th test flight had occurred the day before.

A number of engineering change proposals (ECPs) were now acted upon, but few of their changes were visible from the exterior (some specified the re-routing of internal wire bundles, for example). The production F-15 would feature raked wingtips to improve load distribution on the wing, reduce high-AoA buffet and improve transonic performance. This raked wingtip had the added benefit of increasing specific excess power during supersonic, maximum power accelerations and maneuvers, and was therefore especially welcomed. A small portion of each horizontal stab's (stabilator's) leading edge would be cut out, introducing dogtooth notches to eliminate stab flutter problems. The speed brake would be enlarged and re-tailored to introduce higher levels of drag at lower extension angles, decreasing airflow disturbance over the vertical stabilizers accordingly and allowing McAir to meet the Air Force's deceleration requirements. The new speed brake was now 31.5sqft in area, versus the original 20sqft. The stroke characteristics of the main landing gear on touchdown would be improved in the future, allowing the aircraft to settle onto the gear more quickly at the high speeds immediately following touchdown. This modification was accomplished in concert with changes to the nose steering gain and the manner in which the aileron rudder interconnect (ARI) behaved on touchdown (it was effectively turned off once weight was on the wheels). This permitted the aircraft to land in higher crosswinds.

Impressively, and despite the complications the Air Force was having with press analysis of its accounting methods, McDonnell Douglas was bringing its elements of the Eagle program in below budget and was meeting, or exceeding, each of the 14 project milestones designed to measure the progress it was making. Comparing the new F-15 with the venerable F-4, Burrows and Shawler both noted that the Eagle was well ahead of its predecessor in testing. Category II testing would begin within 20 months of first flight, versus 26 months for the F-4. The F-15 was scheduled for delivery to the first USAF squadron within 28 months, whereas the Phantom II took 31 months.[15]

Air Force involvement in these CDT&E test flights was constant throughout, USAF test pilots flying 51 flights (excluding those in the TF-15) to accomplish the first five AFPEs and 37 other participation flights. In a presentation to the Society of Experimental Test Pilots in 1973, Col Shawler spoke positively about the test program, observing that the engines, radar and gun had all already been subject to competitive evaluations, and that the F-15 evaluation program was designed with: "what I call a semi try-before-you-buy system,"[16] on account of the delivery schedule being slow enough to allow the USAF to evaluate the complete weapon system and request changes without impacting the first production-standard Eagle to roll out of St. Louis.

Shawler praised the Eagle's radar, flight control system, handling qualities and a host of other aspects. He was pleased, too, with accomplishing without adverse effects weapons separation trials – AIM-9 and AIM-7 firings from wing pylons and fuselage stations, and external drop tank jettisons – under critical conditions. The majority of his negative observations centered on the YF100 engine, although he was pleased overall with the progress made in its development. He reported that the F100-PW-100 was slow to develop thrust in certain portions of the flight envelope and that the A/B was prone to blow-outs, or simply failed to light in other portions of the envelope.

ABOVE
F-8 (71-0287) was used for high AoA and spin testing, but also took on the role of testing fuel systems and air-to-air refueling characteristics. It is seen here guzzling gas from a KC-135 Stratotanker. (Boeing via Steve Davies)

ENGINE, CC AND GUN TESTING

P&W's F100 passed its MS6 (preliminary flight rating tests) in February 1972, allowing the Eagle to take to the air with its prototype (YF100 Series I) engines. Because of problems developing the powerful afterburning turbofan, DoD allowed a two-month slip – to May 1973 – for the engine endurance qualification to be passed. This involved running at various simulated altitudes and Mach numbers. That February, seven months after the F-1's maiden flight, an engine shed a fan and turbine blade in a test chamber, effectively failing the milestone requirement as written.

However, the F-15 SPO Director, BrigGen Bellis, stepped in and, within his authority under the JEPO, evaluated and modified the milestone requirement. Investigation into the fan and turbine blade failures showed that they were caused by rust on the walls of the

ABOVE
F-7 (71-0286) was the armament test bed among the Cat I Eagles. It is seen here in October 1973, shooting a live AIM-7 Sparrow. (Boeing via Steve Davies)

engine test chamber. The phenomenal thrust of the F100 at maximum power rattled and shook the test cell so much that the rust flaked from the metal structure and was ingested into the engine. Rust coating the blades affected their cooling and aerodynamic qualities, resulting in the "liberations." Since the problem was with the test cell and not the engine, rather than accept delays which would have meant missing the endurance test milestone and halting the flight testing, Gen Bellis modified two parts of the requirements. He reduced the very high Mach and high altitude phase requirements because these required full afterburner operation and thus were the highest stress points in the profiles. They held the greatest potential for further failures in the contaminated test facility.

While the program's detractors cried "foul" and "subterfuge" the decision was made to keep the engine testing on track. Although the public relations debacle resulted in Gen Bellis being assigned a personal public affairs officer, the matter was truly a technical one and the SPO made the correct decision in the situation. In the final analysis the reduced testing standards had no effect on the F100's ability to perform in the high altitude, high Mach regime. In fact, the engine's problems were not in that area, but in the upper left part (slow speed, medium-to-high altitude) of the "heart of the envelope" where a fighter pilot needed afterburner, and needed it now! But that would only be discovered later.

Owing to all the PR hoopla attending Gen Bellis' decision, a new test program was developed, delivering a successfully tested F100 engine on October 12, 1973 – five months late. With this achievement, the DoD approved FSD for the F100 engine.

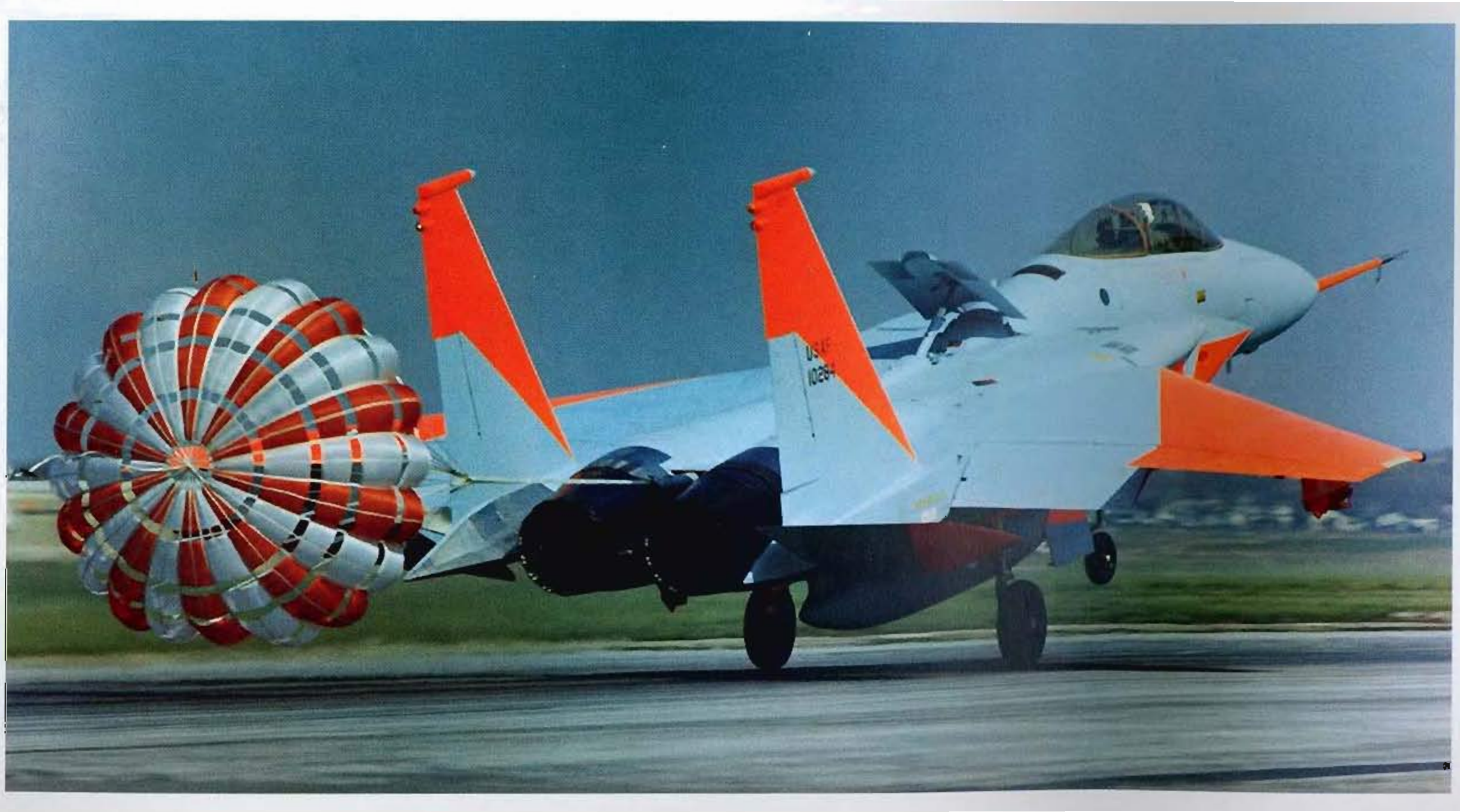
Even from the outset of testing P&W realized it had a temperamental and sometimes unpredictable engine on its hands. Consequently the P&W representatives hovered about the McAir and USAF engine and flight tests like a colony of army ants in white coats, ready to fix anything going wrong. To do so P&W developed excellent ground diagnostic, engine servicing and engine handling (for rapid engine changes) equipment. This helped ensure that problems were addressed and often fixed – even if it required an engine change – as quickly as humanly possible.

The problem was that the JEPO had not required P&W to develop the same diagnostic, servicing and handling equipment for the Air Force. Further, the JEPO had not required P&W to demonstrate performance reliability and maintainability of the proposed ground diagnostic and servicing equipment. Therefore, while the company developed its own highly sophisticated test and diagnostic gear to ensure its product passed its ongoing evaluations, it was designing and developing much more rudimentary and largely untested equipment for the USAF technicians. At first there was no developer/supplier/user agreement on what constituted "on condition" maintenance and consequently the engine maintenance ground equipment was inadequate. Thus the troublesome F100 was to be fielded without the Air Force maintainers having the proper tools to keep it running at maximum efficiency.[17]

Meanwhile P&W, knowing it was breaking much new ground with the F100, had requested, in a June 1971 letter to the JEPO, that the new engine be subjected to evaluation flights aboard the USAF's North American B-45 Tornado flying test bed. It was desired to put the motor through its paces airborne before ever fitting it into the F-15, as had been done with most previous jet

BELOW

This rear view of F-5 (71-0284) shows to good effect the turkey feathers adorning its exhaust nozzles. P&W's engines were plagued with problems, and McAir's inlet ramp design exacerbated these in some flight regimes. The USAF would eventually delete the Eagle's turkey feathers. The spin parachute was used by some Cat I jets. (Boeing via Steve Davies)



powerplants. The company said: "We believe very strongly that the availability of such a vehicle as the B-45 for the investigation and correction of flight associated problems is imperative to the timely operational suitability and readiness of the... F-15 weapons system."

However, at that time the JEPO was confronted by serious cost overruns from the Navy's participation in and abandonment of the F100/F401 program and sought to reduce its costs by denying the request, saying: "The increased engine testing hours and the lower cost by not utilizing the B-45 are considered dominant factors... [Therefore, use of] the test bed is considered inappropriate." Ironically the B-45's flight envelope would have ensured tests in the upper left portion of the F-15's engine operating envelope, just the area where the most critical engine problems would later develop.

Meanwhile, CC development was going much better. IBM ground tested the CP-1075 from November 1972 to June 1974, during which time it experienced a failure of a "relevant nature" only three times throughout its 4,280 hours of testing. To ensure that the impact of the integration of the CC and avionics suite on flight testing would be reduced, McDonnell Douglas installed the entire F-15 avionics suite in a Douglas WB-66 Destroyer to iron out bugs and make the necessary changes. When the time came to flight test the first Eagles at Edwards AFB, the suite was performing almost completely as per customer specification and it exhibited excellent reliability as a result.

Pratt & Whitney F100-PW-100 Afterburning Turbofan

Until the latter part of the 20th century, the F100-PW-100 was the most complex engine ever developed for a fighter and it provided enormous capability for the Eagle. The F100 could produce 23,820lb of thrust at sea level in full 'burner and weighed only 3,020lb, giving it a thrust-to-weight ratio of 8:1. This was significantly greater than P&W's earlier J75 turbojet (powering both the F-105 and F-106) with 4.1:1, the Phantom GE J79's 4.6:1, and the contemporary TF30's 6.2:1.

It was designed to be installed into either the left or right engine bay of the F-15 and comprised five major modular components. Any module could be mounted to any other engine, maximizing flexibility in engine maintenance. The main engine consisted of a "core turbojet" (providing the essential compressor/combustion/turbine sections to run the engine) and a second set of turbines in the rear turning a series of fan disks in the front, encased in a large diameter shroud. These formed the Inlet Fan Module, Core Module and Fan Drive Turbine Module respectively. The others were the Augmentor and Exhaust Nozzle Module and the Gearbox Module (containing the fuel pump and control, oil pump and accessory drive).

The secret behind the immense power and efficiency of the F100 was the mating of a powerful afterburner to a strong turbofan jet engine. The latter was formed by a three-stage fan assembly (Inlet Fan Module) driven by a two-stage fan turbine (Fan Drive Turbine Module) by way of a shaft passing through the hollow turbine-to-compressor shaft of the "core turbojet," pushing large volumes (8:1 compression ratio) of cool, dry air past the Core Module at a bypass ratio of 0.72:1. This whole fan-connecting shaft-turbine assembly was completely free spinning and turned only by the pressures exerted upon it by the extremely hot, high pressure air exhausted through the "core engine's" turbine section. Thus the pilot had no direct control over the fan, but indirect control by adjusting the thrust of the "core."

The Core Module consisted of a ten-stage compressor section crushing the incoming volume of air by a ratio of 23:1 then pushing it into the combustion chamber where 16 fuel nozzles added JP-4 (Jet Propellant 4, later JP-8 fuel) at a rate of 100pph (pounds per hour) at idle. The resultant inferno (2,500°F) turned a two-stage compressor turbine as it exited into the fan turbine.

The explosive end of the F100 was its huge afterburner with its counter-balanced (also known as "balance-beam") convergent/divergent nozzle. The overlapping "iris"-type nozzle leaves, or petals, were powered by engine bleed air and were driven ("dilated") closed by advancing the throttles, to the point where the internal temperatures (especially the critical fan turbine inlet temperature or FTIT) and fan speed reached their limits. At that point the engine's Unified Control (UC; early on called a unified fuel control, or UFC) would open the nozzles to maintain operating temperature limits and control fan speed. At "MIL" (short for "military," that is, full power without afterburner) the F100 produced 14,670lb of thrust. Pushing the throttles

In a $100m contract, Philco-Ford was to provide the internal gun for the F-15. Like everything else in the airplane, it was to be all-new: a 25mm weapon, designated GAU-7A, firing caseless ammunition. While the use of such a weapon had some merit, the caseless rounds proved unreliable, having poor muzzle velocities, inconsistent trajectories and premature discharges, requiring the whole ammunition storage area to be armored to keep the weapon from "shooting down" its own aircraft, a weight penalty McAir would not accept. These problems were not solved by the December 1971 evaluation and the tried-and-true M61A1 20mm Vulcan cannon, a Gatling-type gun, was selected in November 1972.[18]

CATEGORY II AFDT&E TESTING

The early 1970s was a period of transition in the USAF weapons system procurement process. Changes were driven largely by the lessons of, and Congressional legislation resulting from, the C-5A Galaxy and F-111 fiascos. While the titles "Category I" and "Category II" testing were familiar terms in the 1960s, they progressively gave way to the "DT&E" acronyms by the time testing was concluded. Category I, or CDT&E, began with the Eagle's first flight on July 27, 1972, to the end 1974. By September that year the F-15 had been flying for 30 months, had accumulated over 2,700 hours in the air, and had seen eight AFPEs met.

through the "gate" and into afterburner progressively lit off five stages of A/B, adding 9,150lb of thrust. The first sign of an A/B light was the nozzles swinging open to prevent spiking the internal temperatures and pressures well past their limits (and blowing the A/B section off the airplane). Then there would be a sudden, powerful push against the pilot's backside.

Initially the convergent/divergent nozzles were streamlined with overlapping plates called "turkey feathers" that efficiently blended the external air flowing around the fuselage of the aircraft with the powerful jet of hot air exhausted from the engines. However, the complicated mechanism was prone to failure and after Eagles had littered turkey feathers across Virginia and West Germany, they were removed. The lack of the feathers was said to increase the drag of the aircraft by 3 percent.

While we pilots thought we "selected afterburner," actually the A/B light was controlled by the UC and we were only "voting for afterburner." If all the other components of the system also voted affirmative, the A/B would light and we were off to the races. The primary other voter was the Electronic Engine Control or EEC (pronounced "eek"), which "supervised" the UC. The EEC took over as the fan speed and internal temperature approached their limits and opened the nozzles 5–10 percent at MIL. When A/B was selected (and "approved") the EEC regulated the massively increased fuel flow (including A/B) through the UC to control FTIT, scheduled the variable fan inlet guide vanes, and operated the nozzles to maintain proper internal temperatures, pressures and fan speed.

The EEC performed other subsidiary functions, such as opening the nozzles to 80 percent at idle with the landing gear down (to reduce thrust so you could actually decelerate and land the aircraft), increasing idle rpm at higher altitudes and locking out the fifth stage A/B at high altitude/low speed (prime stall/stagnation territory). Additionally it prevented overspeeding of the engine at high Mach numbers. Above Mach 1.4 in "full grunt" (maximum A/B), you could pull the throttles to idle, but the engines would keep running at MIL until you put out the speed brake and slowed down. Once down to .8 Mach, the EEC provided normal idle speed for the engine.

As can be seen from this description, the F100 was – and remained – a complex engine dealing with sudden and extreme increases in pressure, temperature and speed with each afterburner use. Often these happened so fast the EEC did not have time to react to, correct and control them. These problems were at the limits of P&W's ability to corral. In fact, in late 1973, SecDef (Secretary of Defense) James R. Schlesinger visited McAir to see one of the first ten F-15s undergoing CDT&E. Going into A/B the jet experienced a violent compressor stall with a huge sheet of flame erupting from it. Mr. Schlesinger commented to his McAir host that the huge flame would make a good target for a heat-seeking missile. The McAir representative responded by saying: "Pratt & Whitney is working on that."

ABOVE
August 1974 and gun testing follows the November 1972 selection of the tried-and-tested six-barreled M61A1 Vulcan over the caseless ammo GAU-7A. (Boeing via Steve Davies)

On March 14, 1974, Col Shawler's JTF transitioned to AFDT&E, with the USAF test pilots moving to the fore, taking over seven of the Category I jets as well as beginning to receive their own Category II aircraft. While the McAir team, continuing its CDT&E with five aircraft in 1974 and three in 1975, focused on translating the McDonnell Douglas-designed performance into actual aircraft handling qualities and marrying various components from the myriad of subcontractors, the USAF team focused on melding the components into a single weapons system and evaluating the aircraft against the contractual requirements. The USAF team strove to operate the aircraft with a minimum of contractor support while the McAir team focused on incorporating Air Force directed changes into the production cycle and refining the manufacturing process for the first batch of 30 production airframes. Category II testing upped the ante somewhat and over 800 hours were flown in the first seven months, including six AFCT&E (Air Force Contractor Test & Evaluation) 1 hour plus evaluation flights on the same day with the same aircraft.

During AFDT&E the Eagle was cleared to carry AIM-7F and AIM-9E missiles. McAir had been looking closely at the impact on reliability by carrying[19] AIM-7F Sparrows. Its research saw the firing of 59 of the missiles, and they forecast that the new AIM-7F would confer a mean time between failure (MTBF) of better than 500 hours.

Static fatigue testing of the airframe through the equivalent of four airframe lifetimes had been completed satisfactorily. So too had the aerodynamics, stability and handling tests. Series III operational-specification F100 engines had been tested and were found to have satisfactory performance in those areas of deficiency uncovered during Category I evaluation. In areas of maintenance and maintainability, the Eagle was excelling. In one demonstration at Edwards during AFDT&E, an engine change was accomplished in 18 minutes and 55 seconds in order to satisfy a 30-minute requirement. A combat turnaround – loading missiles, fuel, liquid oxygen, oil and performing cursory inspections – had taken just 5 minutes and 50 seconds from the moment the pilot had opened the canopy and shut down the engines. The actual requirement for this latter test was a full 12 minutes.

By the time the production configuration F-15 was ready to be built, the Eagle had increased in weight by a mere 460lb, which was something of an astonishment to the critics who had forecast a bloated Eagle by the time testing was complete. It was common to see aircraft balloon in weight as they progressed through their test programs, mostly as a result of airframe modification or the correction of defects. However, the Eagle had remained trim. Only 100lb of that extra weight was accountable to changes made to the actual airframe. Additionally, because McAir had focused on extensive ground testing and placed heavy emphasis on proof testing prior to building the Eagle, there were only 36 Class I ECPs[20] to be implemented to produce the production configuration F-15 that the Air Force wanted. Of these only 21 actually applied to the aircraft itself. These are measures of great success and were testimony to McDonnell Douglas, the soundness of the 199-B design and, considering that the Eagle could serve well as a strike asset too, it was testimony to Don Stuck and his colleagues in the Advanced Design team.

CATEGORY III OR, MORE ACCURATELY, OPERATIONAL TEST AND EVALUATION

With changes in USAF testing processes, on February 11, 1971 the Deputy Secretary of Defense required that the future operator also be involved in the evaluation of any new aircraft to ensure it fulfilled mission requirements. So, in addition to having test pilots wring out the new jet, it would be flown by TAC pilots. They evaluated it on how it would be employed, not on just how well it flew. Sometimes referred to as "Category III Testing," by the time it came about, it was a two-phase program known as Initial Operational Test and Evaluation (IOT&E) and Follow-on Operational Test and Evaluation (FOT&E). The Operational Test Force (OTF) was composed of five TAC fighter pilots, an Aerospace Defense Command (ADC) interceptor pilot and one AFSC test pilot, all under the direction of LtCol Art Bergman.

IOT&E took place at Edwards and introduced OTF pilots to the F-15. No specific IOT&E sorties were flown, but instead the OTF pilots were integrated into scheduled AFDT&E missions beginning

BELOW
Devoid of the colorful Day-Glo markings of previous years, and now wearing a two-tone gray camouflage scheme representative of all operational USAF Eagles, '280 taxis away from the Edwards ramp. (Boeing via Steve Davies)

in January 1975. These were designed to provide HQ USAF and HQ TAC with "estimates of system operational effectiveness and suitability and identify the need for modifications early in the acquisition process." Emphasis was placed on basic aircraft handling, flying and operational qualities, to include offensive and defensive maneuvers and tracking performance.[21]

Because the test program was already determined by the time IOT&E was developed and there was a strong reluctance to add any costs, such as by adding dedicated flying evaluations, this phase was "add on" in nature and in retrospect seems like a mere afterthought. However, it served the purpose of acquainting the OTF pilots with the aircraft, its capabilities and its potential for the far more important FOT&E, which formally began in March 1975 when AFSC ended AFDT&E and "handed off" the F-15 to its operators.[22]

BELOW
The F-15 Eagle would be America's frontline of defense against high, fast-flying Soviet fighters and bombers. The jet's success against the BOMARC drones showed that technology had come a long way since the days when the F-4 Phantom's primitive beyond visual range capability was limited to dealing only with lumbering subsonic bombers. The Eagle represented a shift to a new era where an F-15 pilot could take on anything that was thrown at him – multiple bandits in any combination of high, fast, slow, or low formations. (Steve Davies: www.fjphotography.com)

Since the first 30 production F-15s had begun to be delivered to the new Eagle Replacement Training Unit (RTU) at Luke AFB, Arizona, FOT&E was conducted there, the OTF sharing aircraft with the 58th Tactical Fighter Training Wing (TFTW). Six F-15As and one TF-15A – the first operational two-seat Eagle, TF-3, also known as TAC 1 at the TAC F-15 acceptance ceremony four months before – were used, flying some 1,111 sorties. The purpose of this phase was to: "verify the operational effectiveness and operational suitability of the production F-15A weapons system."[23] Even though the training of the initial cadre of Eagle instructors had already begun at Luke, the OTF's mission was to prepare the aircraft for operational service by firing its weapons, dropping bombs, evaluating reliability and maintenance, determining operational, logistical and manpower planning factors, and reporting to the CSAF any operational deficiencies noticed.

While the OTF operated out of Luke for ease of maintaining the 58th TFTW jets, missions were flown all over the USA in order to really wring out the jet. The APG-63 was tested against multiple targets at Nellis AFB. Dissimilar Air Combat Training (DACT) was flown during some 900 adversary support sorties against F-5E aggressors, ADC F-106s, and the Navy's "Top Gun" fighter weapons school F-14As (deployed to Yuma Marine Corps Air Station, south of Luke). The M61A1 Vulcan cannon was fired at Eglin AFB and AIM-7Fs and AIM-9s were shot at White Sands Army Missile Range, NM, and China Lake Naval Weapons Test Center, CA.[24]

In one of the more dramatic tests, the Eagle/APG-63/Sparrow combination was sent up against a surrogate MiG-25, ostensibly the primary real world adversary for the F-15. In two separate tests conducted out of Edwards AFB, ramjet-powered Boeing CQM-99B BOMARC[25] surface-to-air missiles were launched toward a waiting, armed F-15. In the first test, with the BOMARC streaking towards the Eagle at Mach 2.7 and 71,000ft, the F-15 launched an AIM-7F with a telemetry warhead that showed it passed within a lethal distance of the target. On the following test, the BOMARC was flying at Mach 2.7 and 68,000ft and a live Sparrow missile blasted it from the sky.[26]

FOT&E formally concluded in July 1976, but the biggest test and evaluation of the F-15, its missiles and its tactics – and to some, even the whole concept of a large air superiority fighter – was yet to come, in a six-month test known as AIMVAL/ACEVAL. This was an event that the 422nd FWS would participate in heavily, but that would have to wait until the latter half of 1977. Three years before, the first production F-15s had been delivered to Luke AFB to begin training a new breed of air warrior, the Eagle Driver.

LA
6089
LA
6065
LA
417

04

F-15 SERVICE ENTRY

THE EAGLE HAS LANDED

The arrival of the first production specification F-15 was conducted with more fanfare and glitz than had accompanied McAir's celebrated roll out of the first pre-production example in June 1972. Two years and five months later, on November 14, 1974, no less a personage than the president of the United States, Gerald R. Ford, was on hand to welcome the newest USAF fighter aircraft, the McDonnell Douglas Eagle, to its first flying unit.

Even the selection of the aircraft's name, "Eagle," was meant to convey to those present everything positive, powerful and purposeful, not only about the aircraft, but about the Air Force and the United States of America. *Haliaeetus leucophalus*, the bald eagle, is the majestic symbol of a proud and powerful nation that had recently, seemingly, been bettered by a backwater, third world country. However, that conflict was ended now. Some 527 USAF and USN prisoners of war (PoWs)[1] had returned home and the Air Force wanted to close that hard-fought but extremely painful chapter in its history. It wanted to do so in part by demonstrating, in a highly public ceremony, that a new day was at hand and that the USAF would never again go into hostile airspace without first sweeping it clear of enemy defenders. The F-15 was a highly visible point of departure for the US Air Force and its arrival at Luke AFB represented the beginning of all things new in the TAF.

The aircraft present on the ramp that day was the 21st Eagle built, two-seat TF-15A-7-MC 73-0108[2] (also known as TF-3) with "TAC 1" emblazoned on its nose. It was being delivered to 555th Tactical Fighter Training Squadron (TFTS, popularly known as the "Triple Nickel"). The "Triple Nickel" was the single most appropriate USAF squadron to begin operations with the new air superiority fighter. During the war in SEA it was an F-4C Phantom unit initially based at Udorn and Ubon Royal Thai Air Force Bases (RTAFBs) as part of the 8th Tactical Fighter Wing (TFW) from Kadena Air Base (AB), Okinawa.[3] As a part of Col Robin Olds' "Wolfpack," the aircrew of the "Nickel" shot down 19 MiGs (seven MiG-21s and a dozen MiG-17s), including four MiG-21s on January 2, 1967 during Operation *Bolo*. It was soon touted as the "largest distributor of MiG parts in Southeast Asia!"

The unit really came into its own flying the improved F-4D and the new, more maneuverable, slatted E-model with the internal M61A1 Vulcan 20mm cannon as part of the 432nd Tactical Reconnaissance Wing (TRW). Flying out of Udorn from May 28, 1968 until well after the end of US participation in the Vietnam War, the squadron was home to such outstanding tactical aviators as Maj Robert A. Lodge (three kills), Capts Charles B. DeBellevue (six kills), Robert "Steve" Richie (five kills), Roger C. Locher (three kills) and John A. Madden (three kills). In total, during Operations *Linebacker I* and *II*, the fighter aircrew of the 555th TFS downed

OPPOSITE
Three Luke Eagles enjoy flying across the Painted Desert in northern Arizona. Nearest the camera, 76-089 was at Luke for ten years (1979–89) before being sent to the 101st FIS, 102nd FIG, Massachusetts ANG. It returned to Arizona for the "boneyard" at AMARC, Davis-Monthan AFB, Tucson AFB. (USAF)

"The Great White Hope": The AIM-7F Sparrow

The main reason for the "Triple Nickel's" success in *Linebacker* was not the internal 20mm cannon in the new F-4Es that recently joined the squadron, but the improved AIM-7E-2 (it scored 14 of the 20 kills, as opposed to one scored by the gun) and the ability to employ it beyond visual range (BVR). While the Sparrow was always intended to be used BVR the environment over NVN tended to be cluttered with friendlies and adversaries alike, usually requiring a VID of the target before it could be fired. But, unfortunately, the Sparrow usually failed to do its job. Out of 612 launches (USAF and USN combined) it shot down only 56 NVN MiGs, an effectiveness of only 9.15 percent. The 12ft-long body of the missile was painted white to blend with the underside color of the Phantom. This, coupled with the pathetic ineffectiveness of the weapon, resulted in it being referred to as the "Great White Hope."

Nevertheless, until the development of an all-new design – the AIM-120 Advanced Medium Range Air-to-Air Missile (AMRAAM) – the AIM-7 Sparrow, modified to home in on the APG-63 radar's reflected energy and enhanced by other changes, would have to do. The 1972 AIM-7F was an adaptation of the Phantom's AIM-7E-2, which was significant in its inclusion of a "dogfight" launch mode. This halved minimum range to 1,500ft by reducing the arming time and had the missile roll one-eighth of a rotation to fly in an X-configuration instead of the normal horizontal configuration.[4] This provided more lifting surface (four wings at 45 degrees versus two at 90 degrees) for higher-*g* maneuvering. Additionally, the F-model had a longer-ranged Hercules Mk 58 boost-sustain rocket motor instead of the E-model's boost-only motor. Furthermore, development of the solid state AN/DSQ-35 electronic guidance and control system (GCS) increased the missile's reliability to 4-5 times that experienced in combat in SEA.[5]

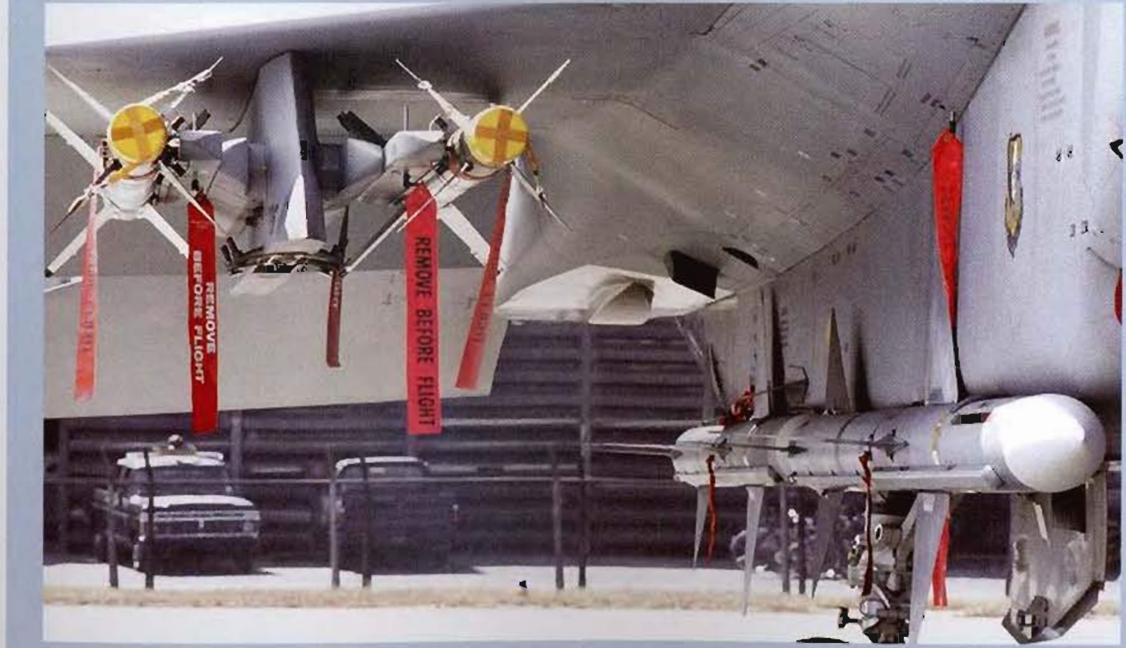
The 510lb missile consisted of four major sections: guidance, warhead, control, and rocket motor. The guidance section enclosed a small, electrically driven, fully gimbaling radar receiver antenna behind an ogive radome that received reflected HPRF energy from the illuminated target, while a wave guide mounted along the side of the rocket motor channeled radar energy from the F-15 for logic, anti-jam and comparative (speed reference) purposes. In addition to the receiver antenna, radome and rear waveguide, the guidance section included an embedded Missile Borne Computer (MBC) and radar fuse unit.

The WAU-10/B warhead section used an 86lb Mk.71 explosive charge surrounded by a continuous rod destructor device. Fusing was by radar proximity using four length-wise antenna strips along the warhead body. The missile was armed by the *g*s of rocket acceleration and detonation was triggered by an electrical pulse activated when the RF energy from its four antennas was reflected back at peak return, that is, the nearest point of intercept, by the target – or the ground. There was also an impact switch (contact fuse) in the control section, which detonated the warhead in the case of a direct hit. Upon detonation the blast would blow the continuous rods outward. These were steel rods with their ends welded to one another in a zigzag, or accordion fashion, so that the entire structure would remain connected as they expanded outward, forming a ring around the initial blast. At maximum extension they would break apart and begin tumbling through space to slash through the soft skin of the target aircraft and cut vital fuel cells, fuel lines, hydraulics and other systems underneath.

The control section was the center section to which were mounted the four moveable, clipped-delta wings. It contained the missile's battery, gyros, autopilot, and hydraulic controls for the wings. Electrical power was introduced by the "fire signal" from the F-15, which energized the battery and activated the hydraulic accumulator to move the wings. Upon self-power, the gyros were spun up, ensuring inflight stabilization and the control section began to receive active guidance signals from the seeker section in the nose. The missile used a speed-based proportional guidance logic. It would intercept the anticipated flight path of the target by steering to a point in front of the target a distance proportional to the relative speed of the missile to the target. If both were going the same speed, say Mach 1, the angle of intercept ratio would be 1:1 (every degree of offset by the target would create a degree of cut-off by the missile). If the missile had accelerated to twice the speed of the target, the missile cut-off angle would be half that of the original vector.

The Hercules Mk 58 solid-fuel rocket motor assembly contained separate boost and sustain propellants in a side-by-side configuration and mounted four fixed tail fins. The motor's boost section was said to accelerate the missile to 1 Mach over the speed of the launching aircraft and the sustain section would keep it at that speed until burn out. Thus an AIM-7F launched by an F-15 at Mach 1 would accelerate to Mach 2, hold that speed until motor burn out and then begin to decelerate. Maximum range varied greatly due to the geometry of the missile intercept, the altitude of the engagement and the amount of maneuvering the missile had to do prior to detonating. Thus an exact number for range cannot be given and any seen in print are without basis. Since the missile's guidance logic was to "meet the target" part way, some of the missile's range was on the assumption that the target continued straight ahead to its own destruction, and thus depended largely on the geometry, speed and altitude of the target. The real maximum range of the missile was whatever the CC computed for that particular engagement.

BELOW
Half an Eagle's load of four AIM-7s and four AIM-9s is shown here loaded on a 12th TFS "Dirty Dozen" F-15C at Kadena AB, Okinawa, in the early 1980s. Earlier versions of the Sparrow and Sidewinder had both been lambasted for their poor performance in Vietnam, and the 1991 Gulf War would demonstrate that while improvements had been made, the Sparrow in particular still had a worrying tendency not to work as advertised. (USAF)



Four of the missiles were mounted to the corner of the F-15 fuselage and held there by two ejection shoes each. Upon "pickle push" the Eagle's CC would "squirt" the target angular location and vector into the missile's MBC, which would position the seeker in the radome to look in the proper direction to "see" the reflected HPRF. The "fire signal" would also activate the battery, spin up the gyros and activate the hydraulics. These processes took time and there was a built-in 1.4-second delay between "pickle push" and the activation of the launch cartridges (similar in size and explosive power to shotgun shells) which extended the "ejection shoes" in a quick, powerful stroke, "kicking" the missile out and down to clear the airframe and underwing fuel tank. A lanyard connected the missile to the body of the aircraft and at full extension it was supposed to be jerked from the missile, initiating the firing of the rocket motor. Once the missile was away, the rocket motor ignited and if the seeker head "saw" the target, the AIM-7F would accelerate out in front of the Eagle and begin taking a cut-off vector to intercept the target. If all the other components of the Sparrow worked as designed, it would blow up at the point nearest the enemy aircraft, thus eliminating it from further participation in the competition.

As one can visualize, the vast and intricate complexity of the Sparrow made for many possible types of component failures. The AIM-7F was painted a medium gray color to blend with the fuselage of the F-15. Even though its Pk (probability of kill) was increased by four or five times (to 36–45 percent effectiveness) over the E-model's SEA record, it was still not trusted to destroy the enemy and every Eagle Driver planned on following the missile to the enemy and unleashing an AIM-9L or maneuvering to guns to complete the kill. Consequently, even though the F-model was a different color, it was still regarded as the "Great White Hope."

ABOVE
Three Luke AFB Eagles ("LA" tailcode) from the "Highly Renowned and World Famous Triple Nickel" Tactical Fighter Training Squadron formate high above the Arizona desert. Note that the nearest F-15A carries a blue AIM-9P practice training missile (PTM) on Station 2A. (USAF)

another 20 NVN MiGs, all but one of them the high-performing MiG-21. Having created the first USAF aces of the war, it was little wonder that the squadron soon came to be known as the "World Famous and Highly Renowned Triple Nickel."

With 39 MiG kills to its credit – more than any other unit in SEA – the squadron was specifically moved from Udorn RTAFB, Thailand, to Luke AFB, Arizona, on July 5, 1974 to become the first training squadron for the USAF's first air superiority fighter since the F-86 Sabre and the air-to-air heyday of the Korean War. Stocked with some of the most seasoned, SEA-experienced F-4 instructor pilots (IPs), the unit set about developing a training program to bring as many pilots as possible quickly up to speed in the new Eagle. The first "students" to go through the "Nickel" – known as the Initial Cadre – were also experienced fighter pilots, many of them IPs, and some of them F-4 weapons instructors, who had been recommended by their commanders from Phantom units all over the TAF. Therefore, the "Nickel's" job initially was just to teach these veterans how to fly the new airplane. This was Phase I of the early F-15 RTU program. Once they were checked out, they would be going to Langley AFB to set up Phase II, which was to teach follow-on students how to employ the jet in combat.

NEW EAGLE DRIVERS

As with determining the actual purpose and configuration of the jet, there was much discussion and debate on the early pilot selection criteria. At first it was thought to limit the cadre to hand-picked F-4 pilots with extensive air superiority experience[6] since the need for a rapid build up in pilots and the limited numbers of aircraft available at first dictated as short a conversion course as possible. It was anticipated that familiarity with the air-to-air mission in general and the experience with radar intercepts and air combat tactics in particular would be an advantage. As it turned out, an individual's adaptability and learning capacity proved to be more important than the type of airplane flown or how much air-to-air experience the candidate had.[7] Consequently, the criteria soon became a minimum of 250 hours' fighter time (type not specified), quality of job records and a personal recommendation from the commander. Regularly timed panels were convened to determine the relative merits of the candidates. They were ranked by qualifications and selections were made from the top down.

At one point, even the Air Force's Surgeon General (SG) office, the branch that includes the USAF's flight surgeons, tried to get into the Eagle Driver selection process by recommending that sitting height – that is the height of an individual when he is sitting in a chair/cockpit – be included in the selection criteria. This was because, in the flight doctors' considered opinion, the shorter individuals had less distance between heart and brain. Physiologically then, it stood to reason that when subjected to high-gs (the early F-15 could sustain 7.33gs instantaneously and 6gs for long durations) the shorter the distance from the blood pump to the brain, the easier it would be to maintain adequate blood volume and pressure in the cranium and maintain consciousness in a hard turning fight. Like time in a specific aircraft, this proved to be a fallacious argument because physical fitness, experience and anticipation proved to be far more predominating factors.[8]

In any event, through this selection process the F-15 Initial Cadre was chosen and soon fighter pilots from TAC, PACAF and USAFE were arriving at Luke AFB for RTU training. These were, in an all-round sense, the "best of the best" chosen from across the TAF and one historian suggests that they represented the top five percent of USAF fighter pilots worldwide.[9] However, while you can build a unit on experienced pilots, very soon the unit will become top heavy with senior Captains and Field Grade Officers (Majors and LtCols). Lieutenants (Lts) are historically the lifeblood of fighter squadrons and new Lts were soon desperately needed in the new F-15 squadrons.

BELOW
The 555th TFTS had a large number of two-seat "tubs" or "family models" for initial transition training, learning aircraft handling, patterns and landings, and instrument procedures. Aircraft 76-130 was delivered on September 26, 1977 and flew as an RTU trainer at Luke and Tyndall AFBs until July 1991, when it was transferred to the 445th Test Squadron, 412th Test Wing at Edwards AFB, California. (USAF)

This said, there were serious concerns about whether a pilot fresh out of Undergraduate Pilot Training (UPT) could handle the power, speed and agility of the Eagle. To test UPT pilots, the Air Force's Military Personnel Center (MPC) established an experimental group of ten F-15 trainees, five brand-new Lts[10] and five Captains who had formerly been WSOs in the F-4 or had flown T-33s/F-106s in ADC. This unnumbered "class" passed its F-15 RTU with flying colors and opened the door for subsequent UPT classes to have brand-new lieutenant pilots assigned to the almighty Eagle.

Clearly, however, only the very best UPT graduates would do. At that time the UPT graduate assignment selection process allowed the top 10 percent of each class to select from a list of available aircraft assignments and the rest were randomly placed in various cockpits by the computers at MPC. The first UPT class to have the F-15 cockpit offered to those in the top 10 percent was Class 76-11. Traditionally – and at this time and for some time to come – the top graduates, aggressive, self-assured individuals who had succeeded at one of the most intense training programs on the planet, naturally desired to go to fighter cockpits. It was no surprise then that nine top graduates from the UPT bases chose the F-15.

Additionally, at this time TAC allowed an ATC T-38 IP to be considered for the F-15. UPT graduates who had elected to remain in ATC as flight training IPs were known as "plow-backs" or First Assignment IPs (FAIPs) and generally these individuals were treated by TAC and its units with disdain because they came to a TAC (or USAFE or PACAF) unit as captains very experienced in flying but totally lacking in combat skills. This upset the rank structure in many F-4 units by having an officer who was senior enough to be a flight commander (in charge of six to eight other pilots on the ground administratively and supposed to lead four-ship formations in the air) but had no experience, credentials (they all started out as wingmen in the four-ships, not the leaders) or credibility to be in a leadership position in the air or on the ground. However, HQ ATC prevailed upon the powers that be in TAC to include a FAIP in this FNG (Fucking New Guy) selection process. To exclude a FAIP but take a brand new UPT graduate with only 210 or so hours of flying time in military jets would have a decidedly negative impact on the morale among the IPs in ATC, and thereby hurt FAIP recruitment. Reluctantly TAC acquiesced and, in December 1976, nine recent UPT graduates[11] and one FAIP formed the first FNG class to appear at the doors of the "Triple Nickel."

It took longer than anticipated for these new guys to reach their designated units. This is because the 555th quickly experienced a slowdown in sortie generation capability. It seems McDonnell Douglas had been overly optimistic about the maintainability and reliability of the advanced systems included in the F-15. At that time the prescribed sortie rate of the TAC RTU squadron was 1.13 sorties per aircraft per day. This meant that a 24 Primary Assigned Aircraft (PAA) unit – having two dozen jets on the ramp – was required to generate and fly 27 sorties each training day. However, the F-15's advanced avionics and F100 engines were failing at an alarmingly rapid rate. With only limited initial spare LRUs available and a long, tedious and costly LRU repair cycle, this meant that half the time there was not a replacement black box to swap out with one that had just failed. Only 48 percent of the LRUs could be tested and repaired at base level; the rest had to be sent back to the contractor for the fix. A similar situation existed with the Pratt & Whitney turbofans. The afterburners frequently failed to light off properly, often requiring an engine change and resulting in a workload of 15 maintenance man-hours of work for every flying hour.[12] While an engine change was a relatively easy operation (compared with the F-4) it still took considerable time and effort and required a spare engine to be on hand to complete. While the unit's maintenance personnel struggled mightily and worked overtime to create training sorties, the lagging logistics channels hobbled their efforts considerably. Consequently, during the first year of operations the best sortie production rate (SRP) achieved was only 0.61, less than half of that advertised by the contractors.

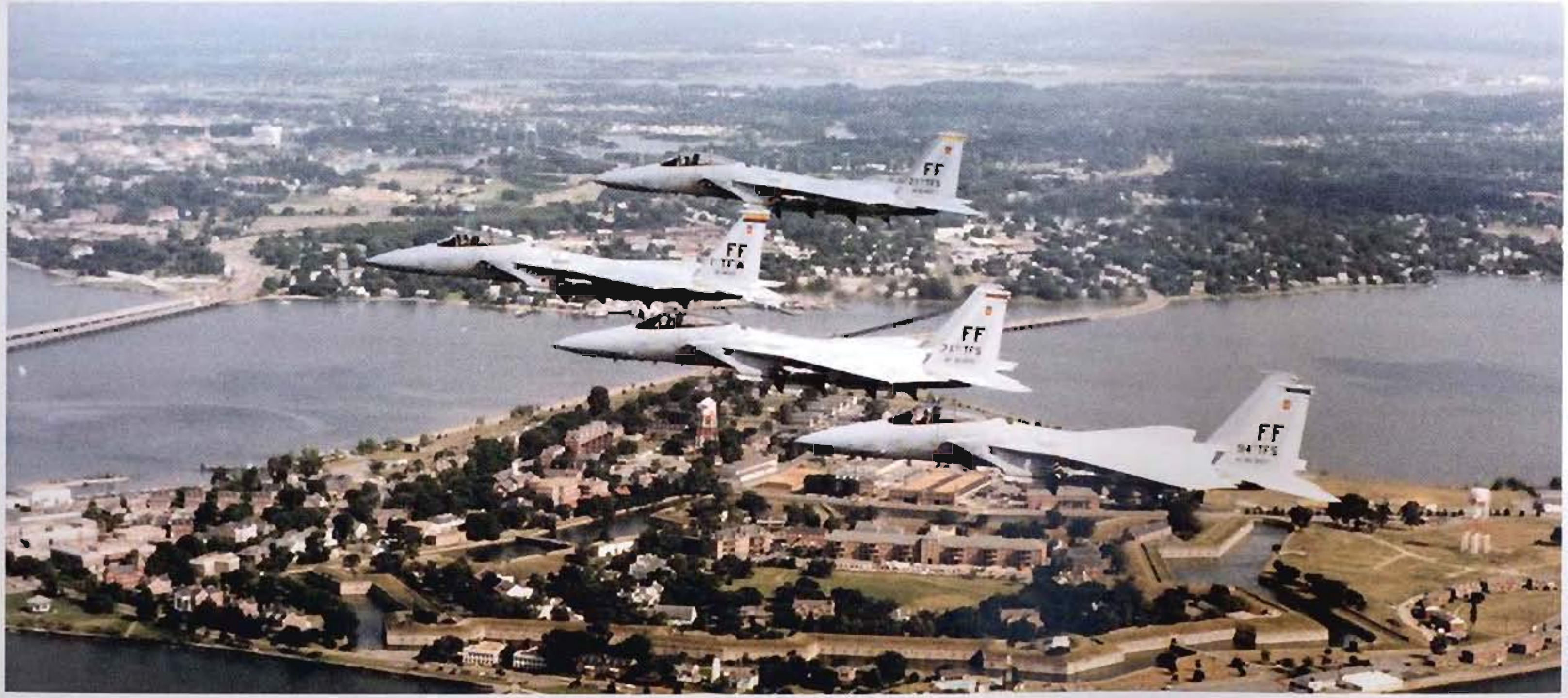
RTU Phase I at Luke consisted of 18-21 sorties for each pilot, flying a combination of transition, instrument/navigation and formation missions. Transition sorties were initially flown in single TF-15As to practice and gain proficiency at various airborne maneuvers designed to instill a feel for, and confidence in the aircraft, traffic patterns and landings from normal, single-engine and no-flap approaches. Once proficiency was demonstrated in these, the new F-15 pilot soloed the Eagle with his instructor flying on his wing to evaluate his maneuvers and landings. Dedicated instrument, navigation and formation sorties were also flown to build proficiency in flying the aircraft in the weather and practicing various formation maneuvers. Additionally, to familiarize the new pilot with the onboard systems for air-to-air and air-to-ground employment, a handful of basic fighter maneuvers and bombing range sorties was flown. Phase I culminated with a Proficiency Qualification check ride, flown two-ship to demonstrate proficiency in landings, instrument approaches and a cross-section of formation work, and pronouncing the new "Eagle Driver" BP (Basic Proficiency), now qualified to fly the airplane of his dreams without an IP's supervision.

Because of the logistics problems and maintenance difficulties experienced by the "Nickel," the required SPR was cut to 0.7, but there was no way to crank out the required numbers of new F-15 pilots at that sortie rate. Therefore, in November 1975 the decision was made to eliminate the three-sortie A/G portion of the syllabus beginning with RTU Class 76 BCL. At that time the F-15 was experiencing problems with its A/G weapons compatibility in the *Seek Eagle* Program and these two factors conspired together to make the F-15 the first USAF fighter (as opposed to pure interceptor) to have no ground attack role. Additionally, the deletion of all A/G training allowed the SRP goal to be trimmed further to 0.65 (much closer to what was actually achievable) and had the added benefit of pleasing the "Fighter Mafia," living up to their motto (repeated by the SPO) of "not a pound for air-to-ground."

THE "ILLUSTRIOUS" FIRST TFW

The newly minted Eagle Drivers graduating from the 555th TFTS – whether seasoned fighter pilots or fresh out of ATC – were destined for Langley AFB, Virginia, to form the first operational Eagle unit, the "illustrious" 1st TFW. Known today as simply "The First Wing," the 1st TFW traced its lineage and heritage back to the 1st Pursuit

BELOW
F-15As of the 27th, 71st and 94th Tactical Fighter Squadrons formate on the 1st Tactical Fighter Wing's flagship over Fort Monroe, Virginia, in this very early 1980s photograph. All four jets carry live AIM-7 and AIM-9 loads. (USAF)



Group of World War One (WWI) fame. Flying French-built SPAD XIIIs over the Western Front against the German Fokkers, Albatroses and Pfalzs, this unit became known for its air-to-air expertise, its kill scores, and its aces, such as America's WWI ace-of-aces, Capt Eddie V. Rickenbacker, commander of the 94th Pursuit Squadron, and Lt Frank Luke, the "Arizona Balloon Buster" of the 27th Pursuit Squadron. In the sparse days following WWI and into the depression years, the 1st Pursuit Group was based primarily at Selfridge Army Air Field, Michigan. It was the US Army Air Service's only pursuit group for 12 years, until the establishment of the 8th Pursuit Group in April 1931. During WWII the unit was designated as the 1st Fighter Group (after May 1942) and fought mainly in North Africa and the Mediterranean using the twin-engined, twin-tailed Lockheed P-38 Lightning in the air-to-air and air-to-ground roles. The unit amassed 440 confirmed aerial victories and created 19 aces in two and a half years of almost continuous combat operations.

After the war, the US Army Air Force seemed to have lost the value of retaining a unit with such a long and distinguished career, and on October 16, 1945 it was deactivated. After a short existence in the late 1940s/early 1950s, mainly at Californian air bases, it was reactivated again on August 18, 1955 as an air defense group equipped with F-86D Sabres. Assigned to ADC and based at its old home of Selfridge AFB, Michigan, the group was redesignated as the 1st Fighter Wing (Air Defense) in October 1956. With the rapid advances in aviation technology through the latter half of the 1960s, the Wing's squadrons flew the North American F-86L (equipped to work within ADC's Semi-Automatic Ground Environment [SAGE] computer and datalink network), the Lockheed F-94 Starfire and Convair F-102 Delta Dagger, and finally received the Convair F-106A Delta Dart in 1960. By this point the unit's traditional squadrons were spread out – the 27th Fighter Interceptor Squadron (FIS) at Loring AFB, Maine; the 71st FIS at Griffiss AFB, New York; and the 94th FIS at Selfridge. Due to the exigencies of the Vietnam War, and the eclipsing of the Soviet bomber threat by intercontinental ballistic missiles (ICBMs), the units were now run down and one by one were closed, with the 1st Fighter Wing (Air Defense) being deactivated in December 1969.

At the time the Commander in Chief (CinC) TAC was Gen William W. "Spike" Momyer, a leader who was very cognizant of the positive influence of rich heritage in Air Force units. He did not hesitate to acquire the "unit flag" with all its history, lineage and legacy for his combat command, saying it was important to: "retain illustrious designators for the active tactical air forces."[13] After six months to organize the transition, on July 1, 1971, the 15th TFW at MacDill AFB, Florida – a replacement training unit (RTU) for the F-4E Phantom – was redesignated as the 1st TFW with its 45th, 46th and 47th TFSs becoming the historic 71st, 27th and 94th TFSs respectively. By that date the 1st TFW was organized so as to evoke the memories, glory and the legacy of the "illustrious" 1st Pursuit Group of WWI fame.

This was just the first step in setting up the 1st TFW as the first operational Eagle unit. The second step was Momyer's May 2, 1972 decision that TAC would base the first Eagle wing at Langley, home of HQ TAC since its inception in 1946. His rationale was that Langley was the "traditional home of tactical fighters." While not necessarily historically accurate,[14] this in turn set the stage for the next step, which was to determine the designation for the first TAC unit to be equipped with the F-15 Eagle. For this Momyer ordered a study to pick the wing designation by having his staff "identify and rank fighter wings by historic illustriousness." It was no surprise that the 1st TFW ranked ahead of all others in the outcome of the study. Now it was only necessary to make it so and thus create, from scratch, a heritage-rich unit in which to showcase the Air Force's latest and highest technology fighter jet.

While knowing the value of history, Gen Momyer also recognized the importance of staying on the best of terms with the Air Force's patrons in Congress. The long air war in Southeast Asia marked the slow transition from a SAC-dominated Air Force to one led by Tactical Air Command. When SAC B-52s were conducting "close air support" missions bombing the Viet Cong and NVN units in the jungles of South Vietnam and tactical fighter squadrons flying F-4s and F-105s were bombing "strategic targets" in NVN, the turn around from the days of LeMay appeared at hand. With TAC now leading the Air Force, what better way to impress Congress and the administration than by basing the USAF's "top of the line" high-tech fighter within a limousine drive from the halls of Congress and the Pentagon? The proximity of Langley AFB, only 90 miles south of the Beltway around Washington, DC, made it a great location to show off the "new toys" that Congress had just bought for the Air Force and Momyer did not pass on the opportunity to set it up. Consequently, the squadrons of the 1st TFW were to be pristine, showcase units, rarely reflecting the norm throughout the TAF and shouldering the burden of hosting VIPs liberally, often at the expense of flying training (by providing numerous VIP orientation flights in the rear cockpit of TF-15As/F-15Bs and Ds).

So with the coming of the F-15 everything was being created new again, and once these three steps were complete, it was a fait accompli that the 1st TFW would move to Langley and become the first operational unit to fly the F-15 Eagle. The first commander of the Eagle-flying 1st TFW was BrigGen Larry D. Welch (future CSAF) and he and his staff had a monumental task to make the flight line at Langley ready to receive the new air superiority fighter and its units. Infrastructure construction, maintenance training, and establishing operations were fundamental issues for the creation of a whole new unit "from scratch" so that the Wing's facilities were complete when the "unit flag" was moved up from MacDill. That coincided with the arrival of the first operational Eagle.

FF
AF 76 071 71 TFS

BELOW
The 71st TFS "Ironmen's" flagship, F-15A 76-071, flies over the harbor of Hampton, Virginia. This "boss's jet" had the ignominious distinction of being badly damaged when another 71st TFS F-15A (76-076) jumped its chocks during an engine run on the ramp and rammed it on November 12, 1983. Both aircraft were subsequently repaired. Aircraft 76-071 went to AMARC, while 76-076 went for permanent display in a park near DeBary, Florida. (USAF)

The movement of the "unit flags" for the 1st TFW and its three traditional squadrons created no small stir, animosity and resentment amid the F-4 drivers and WSOs at MacDill. While the MacDill units had had almost six months to assume the historic mantle of the old 1st Pursuit Group, they lost it in one weekend. The "new First Wing" members, recently graduated from their training in the "Nickel," were anxious to assume their new identity and flew down to MacDill to raid and rape the F-4 units of everything that represented their heritage and lineage. The "old First Wing" in turn became the 56th TFW, a designation that had an outstanding history and rich heritage itself.[15] However, that could not make up for the manner in which the new Eagle Drivers – the arrogance of being the "best of the best" showing through in an unflattering way – had treated them. Thus was the start of a fairly deep and emotional schism among tactical aircrews, where the imperious F-15 pilot was soon known as "Ego Driver," and the F-15 was similarly derided as the "Ego Jet" by those unfortunate enough to never fly it. Because the 56th TFW instructor pilots and WSOs continued to teach aircrews coming through training before going to operational assignments in all three TAF commands, what started at MacDill soon permeated the entire Air Force.

Impervious to the feelings of the "Phantom Phlyers," the new Eagle Drivers stood up the 1st TFW (tailcode "FF" for "First Fighter") and its three attendant squadrons on June 30, 1975. The first operational F-15 (74-0083)[16] arrived on January 9 the next year,[17] and was flown to its new base by LtCol Richard L. Craft, commander of the 27th TFS. The 27th "Fighting Eagles" – a distinct change from the "striking falcon" emblem that the unit wore through both World Wars – received their new aircraft at a rate of eight per month, working up on the new jets to achieve their Initial Operational Capability (IOC) later that year. The 71st TFS "Ironmen" followed suit, receiving their first Eagle in May 1976.

In addition to being the first operational F-15 units, the "Fighting Eagles" and "Ironmen" provided Phase II of the Eagle RTU. This was planned to consist of 22–30 sorties over a 75-day period. Since the trainees arrived from Luke already checked out in the airplane (BP qualified), the IPs at Langley went straight to work teaching them how to employ the new aircraft in combat. First there were three sorties of offensive basic fighter maneuvers (BFM) where the new F-15 pilot practiced attacking his IP from an offensive "perch" position about a mile behind him and offset to one side about 30 degrees. There was also one defensive BFM mission where the IP assumed the "perch" position and the trainee had to successfully defeat his attacks. The bulk of the program included six air combat maneuvering (ACM) sorties where the trainee and his IP engaged a single adversary (usually a third F-15 flown by another IP), both offensively and defensively, the pair working together to kill the enemy in minimum time, even if they started out defensive (adversary behind them). The trainee then graduated to flying three two-versus-two (2 v 2) dissimilar air combat tactics (DACT) missions, usually against the newly established F-5E/T-38 aggressors who flew in from Nellis AFB, and the proficient and very capable F-4E Phantoms from Seymour Johnson AFB, NC, plus local USN A-4s and USMC F-4Js. (The outcomes of these training engagements were never really in doubt.) There were also four air defense (intercept) missions using ground control intercept (GCI) units based in the Langley area and flown against targets such as SAC B-52 bombers and ADC EB-57 electronic jammers. At least one of these was flown at night and included night air-to-air refueling (AAR) from SAC KC-135 Stratotankers. Throughout this training, special emphasis was placed on the tactical scenario expected in the European theater, where it was expected that the new Eagle Drivers would be engaging swarms of Soviet MiGs.

If the trainee exhibited proficiency in any phase, he could advance to the next phase of training. This was helpful in cutting the sorties required to graduate him, which was particularly appreciated since the 1st TFW at Langley was having just as hard a time producing sorties as the "Nickel" was at Luke. Phase II training culminated with a check ride that qualified the F-15 pilot as Mission Ready, fully prepared by TAC's standards and with expectations to be immediately placed into combat in the air superiority or air defense roles.[18]

The first class of six trainees started flying with the 27th TFS on June 28, 1976 and graduated five months later, on November 23. New classes showed up every 30–60 days depending on Luke's hobbling sortie production rate. As the training load increased, some of the trainees became new Eagle IPs by passing a seven-sortie local instructor checkout. Because the 1st TFW needed to keep one of its squadrons fully operational in order to deploy to meet any crisis/contingency needing air superiority, the new members of the 27th were not dispersed to the other two squadrons as originally envisaged. Instead the 71st TFS picked up the training load to build itself to IOC by the end of the year. Meanwhile, the "Fighting Eagles" deployed to Nellis AFB for *Red Flag* on July 6, 1976, only 58 days after receiving their 24th jet.

While the 27th and 71st were becoming operational and conducting RTU Phase II training, the 1st TFW's third component, the fabled 94th "Hat in the Ring" Squadron, experienced an agonizing delay between receiving its jets and achieving IOC. Although its first jets arrived on August 1, 1976, the 94th had to wait until December 1977 to be declared operational. This was mainly because the "Hat in the Ring" Squadron found itself in charge of preparing USAFE's new Eagle squadrons for deployment to Bitburg AB, West Germany, and Soesterberg AB, Netherlands, under a project called *Ready Eagle*.

Thus by January 1977, TAC had two operational F-15 fighter squadrons ready to go to war, with a third forming. McAir had delivered 143 aircraft, one of which had been lost in an accident, and

BELOW
This 433rd FWS F-15A (77-092) moves away from the tanker after getting gas over the Nellis ranges. The squadron was tasked with training F-15 weapons instructors and the badge on the aircraft's right intake is the emblem of the F-15 Weapons Instructor Course. Following its time as a weapons school jet (1981 to 1983) this aircraft was relegated to the training role at Luke, then Tyndall, before being retired to AMARC in 1997. (USAF)

"Corn's" Midair *by* Joe "Corn" Hruska

This event happened years later (early in 1999). I was assigned to the 85th Test and Evaluation Squadron (TES) and "Disco" was assigned to the 33rd Fighter Wing. Both units were located at Eglin AFB, FL.

I was on a 2 v 3 DACT mission when I had a midair with my flight lead. I'll skip through all the preliminaries in the interest of keeping this story short, but the bottom line is we hit at 35,000 [feet], line abreast, just under the speed of sound. When I say line abreast, I mean just that. My jet was about six feet higher than his and about two feet aft. If you took two F-15 models and lined them up facing the same direction with one slightly higher than the other with about 30 degrees of crossing vectors, you have the picture.

I saw the collision occur with enough time to start a full aft stick pull. As anyone can tell you who's witnessed a significant event, temporal distortion takes effect and things seem to happen a lot slower than they are really occurring. I remember watching the two aircraft about to collide with my jet slightly higher, and having a faint hope that I'll pass over the top of his jet. About the time I'm watching his cockpit and turtle deck disappear underneath me (still with full aft stick), I hear a tremendous thud (like hitting a 50 gallon barrel with a baseball bat) followed by a sound of "Ugh" from yours truly.

The next thing that I can recall is sitting in a white fog watching my hands flailing around in front of me. The jet was in some type of corkscrewing rolling maneuver and I was getting tossed around pretty good. The white fog was most likely caused by the rapid decompression at high altitude. About the only thing I could see were my hands, the view outside was pretty blurry.

At this point I made an attempt to reach the ejection handles. The handles sit up near your knees, but I can remember looking straight down at them. The gyrations of the aircraft made it difficult to reach the handles. Imagine being tossed around on a carnival ride under varying gs and trying to position your hands to a specific spot in space, then holding them there. I finally gave up on trying to reach with both hands, and let my right arm flail wherever it wanted, focusing instead on my left hand trying to reach the ejection handle. After several attempts my left hand finally gripped the handle and I was able to pull it.

There is often a lot of interest in what it feels like to eject out of an aircraft. Pilots are curious about the experience, even though we all hope we never have to do it. When it happens to you, some details are branded in your mind and others you have no recollection of. For example, I can recall seeing the canopy leave the aircraft out of the corner of my eye, feeling my calves hit the seat as it started to go up the rails, and watching the floor of the aircraft fall away, but I cannot remember anything that happened in the seconds following that sequence.

I must say at this point I owe a debt of gratitude to everyone who ever taught me anything about survival in an ejection situation. The training automatically takes over, and despite all the chaos around you, you go through the steps you were trained to do.

I knew I had ejected from the jet and the first thing you're taught is to check for a good parachute. As I looked up for the canopy, I thought it was odd how small the 'chute was, and it seemed the wrong color. No bother, it seemed to be working okay, and although very small it was fully deployed. It wasn't until I began to go through the other steps I realized I was still sitting in the ejection seat and basically free-falling with a drogue 'chute to stabilize the seat. At first it was very windy and I felt as though I was struggling with my equipment, but the ride soon stabilized and became very smooth. (So smooth in fact, that I had the impression that in the event I never got a real parachute, I could ride the seat to the water with no problems.)

There is no explanation for some of the things you do in such a situation, but around this time I figured I better help out the accident board that was bound to convene. I checked my watch and noted the time for accurate reconstruction. My line-up card was also still attached to my knee-board which was still attached to my leg. However, it was blowing in the wind and appeared to be coming loose. Don't ask me why, but I became very concerned that the card would blow away and the investigation board would not have access to it. I began to toy with the damned thing to preserve it, until common sense finally took over and I let it blow away in the wind.

As I said, the seat became very smooth and I settled in for a nice ride from 35,000 to about 14,000, where the seat is supposed to separate and you get a main 'chute. I was told later that the free-fall lasted about one and a half to two minutes. If you're curious, the seat, when falling with the drogue 'chute, sits pretty much upright with a small amount of forward tilt to it. The water below was looking as though more and more detail could be seen (3–4 foot seas that day), and I began to worry about getting a main 'chute. It wasn't long before I could hear some clicking in the seat and the next thing I knew I was looking at the seat in front of me. In the next instant my main 'chute opened and I saw the seat zip away below me. That removed all doubts about my ability to ride the seat to water by the way.

This was the chance to follow through with the rest of the steps for ejection. When checking for my visor, I found that it was already gone. I pulled off my mask, but thought it too valuable to just throw away into the Gulf of Mexico (never mind the nice expensive F-15 that was now going to be a reef in the Gulf of Mexico). The seat kit was already deployed, and I released the four-line jettison to stop the swaying of the 'chute and air spilled out of it. By the way, if you're not used to that it can be very disconcerting. If you're still wondering about the mask, I eventually realized I was being stupid by trying to preserve it (as though it were the most expensive part of the jet), and just did an over-hand toss with it and flipped it away, watching with interest until it disappeared from sight.

About this time I began to take inventory of what had happened. I wiggled all my fingers and toes just to be sure they were still attached. I didn't inflate the LPUs life preserver units right away, as I became concerned for my flight lead and began to search the sky for him. At this point I was convinced he was dead, as I thought I had taken the entire top of his jet off. I said a few prayers to the good Lord for him, and was then interrupted by the sight of falling debris all around me.

The most noticeable piece floating down nearby was a wing, I believe the right one. (One of those sights that is branded into your brain.) It was fluttering end over end like a leaf in the wind and I could clearly see fuel lines sticking out of one end. It must have been no more than 100 feet below me. How it missed me and the parachute, I'll never know. There were all sorts of dark green objects in the air around me as well. I never figured out what those were.

Sometime during the fall in the 'chute I finally caught sight of my flight lead. He had ejected as well, and I could see him hanging from his parachute. He was a little lower than I was, and the first I knew for sure he was alive and kicking was when I saw him crawl into his raft. There is no description for the relief felt at such a sight. You have to experience it to appreciate it.

While in the parachute I started to notice a lot of splashes in the water below me from pieces of falling aircraft. I distinctly remember seeing the seat make quite a splash, and being thankful I wasn't riding it anymore. The wing I saw was now further away and also made quite a splash in the water.

The adversary aircraft we were fighting were now on the scene and they quickly spotted both of our parachutes. Flying by and giving us each the obligatory once over, they could see we were okay. I tried to wave my legs and arms but succeeded in looking like a deranged man trying to do jumping jacks. They got the message though.

After watching lead get into his raft, it was time to prepare for the splashdown. The landing was smooth with the seas about 3–4 feet with big rolling swells. I quickly got into the life raft prepared for a long stay. However, rescue forces were already on the way. (We were in the rafts for about 45 minutes, no time to even get bored.)

The rescue has a few good stories in itself, but I'll save those for another day. Suffice it to say I owe a debt of gratitude to the crew of COWBOY 22, an MH-53 from Hurlburt Field which happened to be out on an instrument check-ride when the call came for a search and rescue. They, as well as the F-16s who ran the SAR CAP, executed a flawless recovery and there are two happy F-15 pilots to prove it. By the way, if you're wondering what this has to do with "Disco," he was the Board President for the investigation. I'll have to learn to avoid being stationed at the same base as he is!

over 25,000 hours had been flown in the type. In addition to the 20 test and evaluation airframes, some 51 of these jets were stationed at Luke AFB where a second RTU squadron – the 461st TFTS "Deadly Jesters"[19] – would be formed on July 1, 1977. Another 63 Eagles were on the ramp at Langley with the three squadrons of the 1st TFW. Two other TAC airframes had been delivered to Nellis AFB, where the 57th Fighter Weapons Wing had decided to set up a separate squadron to develop new tactics to take advantage of the quantum leap in lethality that the Eagle represented. Six more were in the process of being taken on strength.

While the 555th TFTS at Luke and 27th TFS at Langley trained their students – both old hand F-4 pilots and FNG UPT graduates and FAIPs – through 1975, 1976 and into 1977, the brand new 433rd Fighter Weapons Squadron[20] of the 57th Fighter Weapons Wing (tailcode "WA," although initially the 433rd's aircraft carried Luke's "LA" on the tail) began exploring just what could be done with this advanced new fighter. The squadron was activated – formalizing the pre-existing F-15 section as a full-fledged fighter weapons unit at Nellis AFB, Nevada – on November 1, 1976. Eleven days later, the squadron commander, LtCol David "Jake" Jacobsen[21] flew in the new squadron's first F-15A, serial 75-0042.[22] The unit received five more Eagles, including two TF-models, by January 1, 1977 to complete its initial complement.[23]

Tasked with training the weapons instructors for the new squadrons of the First Wing, the "Satan's Angels" spent more than a year establishing their unit as a flying organization and participating in various F-15 weapons tests before starting the first class. The extremely dynamic, high-*g* air-to-air combat training quickly proved to be a very risky business with very high potential for midair collisions as the two – or more – fighters merged at speeds in excess of 1,000 knots and then maneuvered aggressively against each other to get into a "killing position" on the other. Even momentary loss of sight in a maneuvering engagement – looking away to keep track of another adversary in the fight, or to "check six" – especially at the moment the opponent was changing his flight path to counter the most recent move by the Eagle, could be a fatal lapse.

The first loss suffered by the squadron was the first example of this hazard. F-15A 74-0129 collided almost head-on with an F-5E aggressor on the Nevada ranges on February 28, 1977. The damaged Eagle proved uncontrollable and its pilot safely ejected. Amazingly the F-5E was able to return to Nellis. This high-risk hazard would eventually (up until 2004) result in a total of 20 collisions, destroying 26 USAF F-15s and claiming the lives of ten Eagle pilots.[24] One of the pilots to whom this book is dedicated, Capt Rich "Hub" Kendel, was one of those ten.

The first class of the F-15 fighter weapons instructors course (FWIC, now simply WIC) started in January 1978. The classes were small, usually only four to six trainees each, and each took four months, but they produced absolute experts on the F-15's physical and aerodynamic characteristics, its weapons systems and the tactics to best employ the new jet. When these weapons and tactics experts graduated, one would be placed in each of the new Eagle squadrons as they were activated. Their job was to transfer their knowledge to the newer and less experienced Eagle Drivers in these new units.

During that time, the weapons instructors of the "Satan's Angels" and their students quickly realized that they had an extremely capable aircraft on their hands. Col Dick Anderegg,[25] in his book *Sierra Hotel: Flying Air Force Fighters in the Decade After Vietnam*, stated: "When I checked out in the F-15 I had over 2,000 hours in the F-4, 365 combat hours, and two tours as a fighter weapons school instructor. On my seventh or eighth F-15 flight I remember thinking, 'Damn! I'm just learning how to fly this jet, and I'm already more lethal in it than I ever was in the F-4!'"

"THE TOWERING INFERNO": AIMVAL/ACEVAL TESTS

Like eight Old West gunfighters at high noon at the OK Corral, four Eagles and four aggressors squared off and faced each other, 40 miles apart, high above the Nevada desert. The "corral" was the circular Cubic Corporation Air Combat Maneuvering Instrumentation (ACMI) range and they closed at a combined velocity of over 1,200 miles per hour, hell-bent on killing the members of the other side. The aggressors came at the Eagles in two pairs, each close together. The Eagles advanced against them in a ragged line abreast formation, radars ranging way out in front.

But the Eagles "missed the 'sort'"[26] and all four targeted two F-5Es, calling them "dead" with simulated radar-missile shots before the merge. The two "live" aggressors saw the large F-15s at a long distance and as they merged, called two of them "out" with simulated front-aspect IR-missile shots. The pair of "live" Eagles saw the pair of "live" aggressors at the merge and the four began hard, fast and confused maneuvering to bring their noses to bear.

ABOVE
AIMVAL was designed to determine the USN's and USAF's needs for a modern heat-seeking missile for the new F-14 and F-15. The result was the all-aspect AIM-9L, the improved "Mike"-version of which is seen here being carried by a 94th TFS F-15C (81 040) on patrol over Washington, DC, after the 9/11 terrorist attacks. (USAF)

Thanks to HOTAS and Auto Acq radar modes the Eagles got radar locks and quickly had simulated radar-missiles in the air at both opponents. Thanks to the F-15's large size, the F-5s put their noses on the two Eagles and unleashed their front-aspect "heaters." The Eagles' missiles "destroyed" the F-5s but almost immediately thereafter, the aggressors' missiles – according to the ACMI computer model "fly outs" – "impacted" both F-15s. They had been "killed" by "dead men."[37]

The simulated air battle, flown with real pilots in real airplanes, had taken 1 minute and 52 seconds from the first simulated missile shot to the last simulated kill and all eight players had "died." This sensational, watershed event was known as the "Towering Inferno," named after an epic Irwin Allen disaster movie of the day, and was widely billed as one of the most dramatic – and telling – engagements of AIMVAL/ACEVAL,[38] the DoD-directed Air Intercept Missile Evaluation and Air Combat Evaluation.

While not a valid AIMVAL/ACEVAL event, but a practice "work up" for the actual tests, "Towering Inferno" and the tests themselves became misconstrued and misinterpreted to fit the agendas of those who argued either for or against "big fighters" (F-15 and F-14) and the sophisticated, but not yet mature, weaponry they represented.

AIMVAL began as a test to evaluate five different IR-missile concepts, each of the "virtual missiles" being able to be programmed into the software of Cubic's mainframe ACMI computers and thus be replicated in actual aerial engagements. These included the USN's proposed off-boresight, vectored-thrust missile; the USAF's electronically cooled front-aspect IR-missile; and Raytheon's AIM-9L Product Improvement Program. ACEVAL grew out of AIMVAL as an opportunity to take advantage of the large forces gathered for the missile tests in evaluating the best possible tactics for the new high-technology fighters of the US Navy and Air Force.

Red Force was played by USN and USAF F-5E aggressors using similar front aspect IR-missile capabilities on the assumption that by the mid-1980s the Soviets would also have this same technology (plus this would add more data for the missile evaluations). Additionally, the aggressors had GCI control just as the communists used in SEA.

BELOW
The complete package: a 94th FS "Hat in the Ring Squadron" F-15C with AIM-9Ms and AIM-120 AMRAAMs. Improvements in the aircraft, IR and radar missiles were presaged by the AIMVAL/ACEVAL results. Aircraft 81-040 was delivered December 22, 1982 and remained with the 1st TFW throughout its service life. It was replaced by an F-22 Raptor in 2006. (USAF)

Blue Force was played in part by the 422nd FWS which borrowed an additional six new F-15s from the 555th TFTS (and in doing so cost the RTU 262 training sorties, delaying the graduation of some 14 new Eagle Drivers headed for the 1st TFW) and had their CCs reconfigured to present front-aspect missile WEZs.[29] The Navy's VX-4 (similarly bulked up with VF-1 and VF-2 aircraft) from NAS Point Mugu, California, flew Tomcats. For ACEVAL the "big fighters" were allowed to use standard AIM-7Fs, AIM-9L simulations and their guns.

To successfully evaluate possible IR-missile characteristics, the planners, programmers and staff officers limited the Blue Force Eagles and Tomcats to requiring a positive VID of the enemy Red Force, hobbling the good guys' ability to use their primary weapon, the AIM-7 (simulated by a generic radar-missile, designated SS-1 for AIMVAL). This was supposed to effectively limit the players to a "heater and guns" scenario for the best evaluation of the five variants of the virtual IR-missiles (known generically as SS-2s). However, the evaluators failed to take into account the nature of the fighter pilots flying the jets.[30] Fighter pilots, like all warriors, are wont to throw away their longest range weapon or fight on "equal terms" and various means (such as the "Eagle Eye" rifle telescope) and changing tactics were adopted to optimize the SS-1 under the VID-required stipulations.

Likewise, using police radar detectors (called "fuzzbusters" back then) duct-taped to their glare shields to alert them that the APG-63s and AWG-9s were "lighting them up," aggressor pilots learned to dive into the "notch" and stay in the "beam" (both terms referring to that area of Doppler frequency shift represented by the fighters' speed over the ground and therefore filtered out by the radars' computers).[31] They would hide there until hopefully they were underneath the Blue fighters' radar coverage, and on a call from their all-seeing GCI would attempt to ambush the big fighters from "out of the weeds."

The acute sense of competition of these Type-A fighter pilot personalities on both sides saw trickery employed as well as tactics and simulated missiles. For instance, one F-14 pilot going against a USN aggressor in a 1 v 1 scenario indicated the engagements would be "guns only." He VIDed and killed his opponent with a Fox One (AIM-7) on both passes. In the debrief, the angry aggressor pilot challenged the Tomcat driver's "cheating" by asking "Hoser," LtCmdr Joe Strapa, "what the hell happened to credibility?" "Hoser," with appropriate thumb gestures accompanying his response, replied: "Credibility is down, kill ratio is up!"[32]

AIMVAL began in June 1977 with 540 valid engagements required, involving over 1,800 sorties. These engagements graduated from simple 1 Eagle versus 1 aggressor (1 v 1), to 1 v 2, 2 v 2 and 2 v 4. ACEVAL explored tactics and other factors affecting air combat outcomes such as force size, force ratios, and initial conditions (Blue advantage, neutral, or Red advantage). To do so it added 2 Eagles v 1 aggressor, 4 v 2 and 4 v 4, so that all pairs combinations of up to eight engaged aircraft were observed. It required 360 valid engagements and took another 1,488 sorties to get them. Additionally, hundreds of other sorties were used to work up to the required level of proficiency so that all the players had about the same skills in multi-bogey (4 v 4) as well as individual (1 v 1) engagements.[33]

By the time ACEVAL concluded in November, the missile tests had shown that the new IR-seeker heads on the other four concept missiles were no better than that of the AIM-9L and the other programs were canceled. The results from ACEVAL were far more contentious. The trials showed that the F-15 performed well in the 1 v 1 environment, with a kill ratio of 18:1 when beginning from a Blue Advantage position, and averaging higher than 3:1 overall, regardless of set-up. However, as more and more players were introduced into the scenario, the fact that the APG-63 radar was tied to a single adversary, denying the pilot of situational awareness of all others – plus the large size of the Eagle making it almost a beacon for Red Force to home in on – reduced the ratio to 1.5:1. When the Eagles were outnumbered (1 v 2 and 2 v 4) it was barely above 1:1.[34]

These results, however, were unscientific, incomplete and tainted by the "players'" individual performances, yet they were interpreted to "prove" different things to different people, depending on the preconceived notions or political agendas of the beholder. Even John Boyd, now a retired colonel and consultant to the Office of the Secretary of Defense (OSD), stated that the results would "be incorrectly interpreted," and he was right.[35] While the advocates of small, unsophisticated but highly maneuverable fighters hailed the

"Eagle Eye:" The Poor Man's Long-Range VID and other Innovations from AIMVAL/ACEVAL

During F-15 FOT&E, the limitation of a VID requirement severely restricted the use of the improved-performance AIM-7F, a fact significantly underscored during ACEVAL tests that followed. This led many to conclude that an unaided VID would put the Eagle within the enemy's weapons engagement zones (WEZ) before the Eagle's longer-ranged weapon could be used. Since the F-15 would not be fitted with the F-4E Phantom's TV-like, long range TISEO (Target ID System – Electro Optical) because strict weight limitations and cost milestones would be exceeded, an alternative solution was required.

In 1976, as FOT&E was being concluded, Maj Jim Postgate had observed the accuracy with which the CC computed the direct line-of-sight to the target in the HUD and thought that if a simple optical device could be mounted to the HUD, a VID might be obtained at much longer ranges than with the naked eye. The idea was to align the device – such as a common 4 x 12 variable-power hunting rifle telescope – with the centerpoint of the HUD (where the "W"-shaped "waterline" symbol was displayed) and once the adversary aircraft came into view in the TD box, pull the nose of the F-15 to put the opponent on the "W," then peer through the rifle 'scope to ID the target.

Convinced that this was a practical and low-cost solution to the problem that had plagued BVR employment since its inception, Maj Postgate formally recommended to the F-15 SPO that such a device be tested. The device – nicknamed "Eagle Eye" – and its HUD mountings were tested by AFSC at Edwards AFB and judged to be only "partially successful," with significant vibration and harmonization issues. However, the test pilots at Edwards were not being "shot at" in AIMVAL/ACEVAL and a Rube Goldberg/Heath Robinson solution[36] was better than none for the Eagle Drivers participating in the Nellis evaluations.[37]

There were indeed problems with using "Eagle Eye," such as attempting to hold the target on the "W" while leaning forward (and moving your upper body towards the stick, changing the angular relationship of your shoulder and elbow to fly the airplane) to peer through the rifle scope. It was as if you were looking at the world through a soda straw. With closing velocities of over 1,000mph, you did not have many opportunities to sight the guy in the scope. However, if you did, a VID on an F-5E could be had at 5nm (usually by discerning the distinguishing wingtip-mounted missile rails) instead of the usual 1.5nm. With necessity being the mother of invention and ACEVAL hobbling the Eagle Drivers with the VID restriction for AIM-7 employment, any means were sought in an effort to realize the "first look; first shot" capability of the "Fox One."

As a result of the "Eagle Eye's" qualified success, nine-power Bushnell 'scopes were issued to every F-15 squadron. When we "hot tuned" our jets on Air Defense Alert we sighted-in (boresighted) the 'scope on whatever object was in the distance under the "W" in the HUD. When flying DACT in VID-required scenarios, we would "check out" an "Eagle Eye" from the squadron weapons shop, mount it on the HUD, boresight it and then could use the AIM-7 in the manner for which it was designed.[38] In January 1991, F-15s flew into combat against the Iraqi air force with "Eagle Eyes" mounted to their HUDs, vindicating Postgate's concept from 15 years before.

An even better tool developed during AIMVAL/ACEVAL was the "Lock/Shoot Lights" mounted to the canopy bow. The CC generated "shoot cues" on the HUD and VSD whenever a target was in range and the nose of the Eagle was pointed in a direction allowing the use of an AIM-7 or AIM-9 against it. However, the Eagle pilot had to be staring at the VSD, or looking through the HUD (only 20 degrees of the 360-degree visibility and arena of an aerial engagement) to see them. In the high intensity of dynamic visual air combat maneuvering, if the radar "snagged" a lock on through one of its Auto Acq modes, the F-15 pilot would not notice it until afterwards because he was looking outside. To remedy this the 422nd FWS had maintenance mount two unmarked (2cm) square amber lights on the canopy bow at ten and two o'clock and wire them to the CC shoot cue generator. If the radar locked onto a target, the lights would glow steady. If the CC generated a shoot cue to the HUD and VSD, the lights would flash. They were controlled by the caution/warning lights rheostat and were bright enough to get the pilot's attention even in broad daylight. These of course proved extremely useful in a multi-bogey environment where an F-15 was maneuvering against one adversary and another one (usually unseen) was attempting to enter the fight. Soon this simple modification was made to the entire fleet of Eagles.

Other innovations from AIMVAL/ACEVAL included the Sierra Engineering Company's Lightweight Helmet (LWH), to relieve the stress and strain on the pilot's neck when maneuvering at 7-*g*s. Some 20 test examples were provided to AIM/ACE participants on both sides for evaluation and it proved to have improved peripheral vision (indispensable in visual maneuvering) and excellent stability under high *g*. However, it still required work from a fit and comfort standpoint and was unacceptable at that point in development. In the early 1980s the gray form-fit Gentex HGU-55 LWH became standard for the Eagle force.

Another was the Visual Identification Target Acquisition System (VITAS). This was a helmet-mounted sight (HMS) that when placed over an opposing aircraft was supposed to activate the weapons system to destroy it. Well before its time – and termed an "I wish you were dead" HMS – the system was bulky, heavy and required a significant portion of the aircraft's CC capacity. However, today the concept is being brought to fruition with the Joint Helmet Mounted Cueing System (JHMCS) currently being fielded for use in the F-15C, F-16, F/A-18 and F-35 in order to fully employ the high off-boresight AIM-9X.

results as vindication of their position on the basis of aircraft cost per loss,[39] more objective observers went away with significantly different lessons learned.

The most significant issue to be resolved was that the F-14 and F-15 needed a faster and longer-ranged, point-and-shoot, launch-and-leave, active radar missile that did not tie the "big fighters'" radars to a single target. This was the genus of the Advanced Medium Range Air-to-Air Missile, or AMRAAM. Additionally, to employ it properly Eagles and Tomcats needed means to ID not-yet-visual targets at optimum missile ranges, allowing them to shoot and depart before entering an enemy WEZ. This would result in both technical (Non-Cooperative Target Recognition – NCTR[40]) and electronic (EWWS) means being developed for the F-15. Furthermore, a radar that would track known targets while scanning for others (track while scan or TWS) and could engage multiple targets simultaneously (with AMRAAM) was needed. Interestingly, all of these would come together as the Eagle matured through the Multi-Stage Improvement Program (MSIP) in the mid-to-late 1980s and in doing so, the days of any adversary's simple, light and cheap clear-air day fighters were truly numbered.

0063
LA
LA
LA
LA
6069

05

HAPPINESS IS... GEASLES AND A SWEATY G-SUIT

This chapter was written by the retired fighter pilot member of the Davies-and-Dildy team and as a result is intended to give the reader an appreciation for what it was like to fly the F-15, to be in an F-15 squadron and to fight other fighters of the day. For this exposition, I rely on my background of three tours in the Eagle – as a member of the 36th TFW's 53rd TFS "Tigers" at Bitburg, as Commander of the 32nd FS at Soesterberg, and as Vice Commander of the 33rd FW "Nomads" at Eglin – and well over 1,000 hours of flying the jet. My operational experiences range from intercepting Soviet "Bear" bombers shadowing NATO naval task groups in the North Sea to chasing (but not "bagging" one of) Saddam's MiGs over northern Iraq. For training, I've participated in five *Red Flags* and a *Maple Flag*, two WSEP missile shoots, AAFCE/AIRCENT's Tactical Leadership Program and numerous DACT deployments. (Additionally I served as the F-15 Evaluator on the NATO Air Defence Tactical Evaluation Team which gave me a broad understanding of how the Eagle fits into NATO's air defense network, and as the F-15 Inspector on the USAF IG Team (formally titled the AF Inspection Agency), although in three years in that role I never laid eyes on an F-15, such are the incongruences of the US Air Force.

These experiences are entirely common for any USAF pilot with three tours of duty in the F-15 and there is nothing exceptional about them, or me. However, they do provide the background to help explain a bit about what it was like to be an Eagle Driver and fly the most powerful operational fighter known to man (at least during the last quarter of the 20th century). In doing so, these experiences have created the assortment of recollections, impressions, observations' and opinions that are presented here.

A LOOK AT "GOD'S JET"

"Awesome!" The word leaps to mind the first time a new Eagle Driver walks out to the F-15. It is an imposing machine, standing tall and proud on its landing gear, the long tapered nose pointing purposefully out into the air, the twin, dark, gaping tunnels of the afterburners waiting patiently to be fired up. The pilot carries a helmet bag and "brain bag" and strapped across the tops of his thighs, atop the leg sheaths of the g-suit, is a small pad containing the day's mission data card.

Approaching the jet – these days called "God's jet" in honor of its immense and awesome power – the aircraft's crewchief comes to attention and renders a salute. Returning it, the Eagle Driver, whether he be a lieutenant on the ramp at the F-15 Flying Training Unit, or a full colonel commanding a wing of Eagles, is handed the maintenance (known as AFTO 781) book and the crewchief begins

OPPOSITE
Headed by the 555th TFTS F-15A 76-063, a formation representing all four squadrons of the 405th TTW flies high above the Arizona desert in the early 1980s. The wingmen jets are from the 426th TFTS (red tail stripe) "Killer Claws," the 461st TFTS (yellow stripe) "Deadly Jesters" and the 550th TFTS (silver on black stripe) "Silver Eagles." (USAF)

ABOVE
Sometimes it was hard to believe they were paying us to do this: fly (and fight in) the most awesome air superiority fighter known to man. Loaded with "wall to wall missiles," mounting an internal gun, and able to sustain its maximum performance *gs*, the F-15 was the ultimate air-to-air killing machine of the 20th century. Here 77-117, of the 49th TFW's 8th TFS "Black Sheep," shows off its armament suite high over the mountains and desert of New Mexico. This aircraft was destroyed in a crash on June 12, 1993 when on strength with the 122nd FS Louisiana ANG. The pilot ejected safely. (USAF)

to brief him on the status of the jet and on any particular subsystem that has had a problem recently. Satisfied that he knows as much as he needs to, the pilot begins his walk around – the visual inspection of the jet, its missiles and external tanks – while the crewchief mounts the ladder to place the helmet on the canopy rail and the "brain bag" in the map case.

The pilot begins his inspection by checking the pitot tubes and AoA probes and ensures that the forward panels covering the numerous radar LRUs are securely locked down. Rounding the immense nose, behind which resides the APG-63's three-foot diameter planar array radar antenna, he gives a shove to be sure the radome is latched shut.

The F-15 is large for a fighter and it is immense, even imposing, as a dogfighter. In it McDonnell Douglas corrected all of the faults of the F-4 Phantom and created few new ones. The jet stands high on its landing gear, enabling munitions personnel to get beneath it easily to mount the four AIM-7s (now AIM-120s) on the four fuselage stations, fill the Vulcan's ammunition drum with 940 rounds of 20mm shells (through a hatch in the belly) and attach the 610 US gal external fuel tank to the centerline pylon. This arrangement eliminated what were known as "Phantom Bites" by the F-4 maintenance and munitions personnel who were constantly being nicked by the low-hanging pylons, rails, racks and gear doors of McAir's previous fighter. The Eagle Driver dives below the belly to open the gun hatch and ensure that "rounds limiter" is set; training missions are normally flown with a fully loaded gun,[1] so we just want to be sure that none of the bullets actually shoot when we pull the trigger on practice gun shots.

Similarly, beneath the right wing root the Vulcan's breech hatch is opened – and many Eagle Drivers have to tiptoe, stretch and maybe even jump a bit to open it, the jet is that tall – and the gun safing pin and cam holdback tool are inserted, to further ensure that the gun is safe and will not actually fire when the trigger is squeezed.

On the wing pylon rails, the AIM-9 practice training missile (PTM) and any other stores are inspected. The yellow rubber seeker cover is removed and the missile's little "eyeball" is examined for defects. Moving down the body of the missile, the argon bottle quantity – argon cools the missile's seeker head enabling it to see and discriminate lower spectrum heat sources – needs to be "in the green" (a band on the pressure gage), the missile should be securely mounted on the rail, the umbilical must be attached and the rollerons seated in the fins and able to spin freely. The inspection of a PTM varies little from the inspection of a real missile.

Around the wingtip and back to the tail, the eyes of the Eagle Driver look over the flight control surfaces for any deformations or abnormalities and, standing between the tails, his hands play a bit with the moveable nozzles, ensuring there is no binding. Rounding the left wing, looking at the same things on the other side, the pilot makes his way to the cockpit ladder. Eagle Drivers rarely carried their checklists with them (although in TAC/ACC this was required, so we would do it on check rides and during stan/eval [standardization/evaluation] visits and IG [Inspector General] inspections) for these inspections since there was so little written under the *Exterior Inspection* section, and it was all plainly obvious by just looking at the jet.

Usually the crewchief awaited your arrival topside by standing on the left intake. The only thing to check when you got to the top of the ladder was that he had remembered to remove the heat exchanger exhaust cover (the exhaust vent was located immediately aft of the canopy hinge). Atop the ladder you are easily 12 feet off the ground and, swinging one leg over the rail and into the cockpit, you "mounted" the beast, dropping down into the saddle of the ACES II ejection seat. With the crewchief's assistance, you then buckled the Koch (pronounced "coke") fittings of your harness into the risers of the parachute mounted in the headrest of the ACES II. You also clipped the buckles of the survival kit, mounted in the seat bottom beneath the cushion, to the sides of your harness, and connected the hose from your *g*-suit "chaps" into the receptacle in the left console. On the right side of your harness you snapped the CRU-60 oxygen and communications assembly into place on your chest. Connecting the oxygen hose and communications cord of your helmet there, it was now time to don the "brain bucket" and get on with the business of "firing the mother up."

From atop the F-15, the pilot has a commanding view of all about him, not only because of the height of the jet, but also because the seat sits very high in the cockpit. With the canopy lowered, as is normally done immediately after engine start, your arms rest naturally along the canopy rails in a relaxed and comfortable position. You definitely feel in charge.

There were a lot of switches to check before you started the engines but mainly you had to be sure that they were all "OFF" so that any electrical surges associated with the generators coming on line did not damage any of the subsystem components. As with the external inspection, this was usually done without a checklist because simply looking at each switch and ensuring it was in the proper position for engine start was sufficient. There was a short, 13-item "Verify" checklist of the critical items to be checked to avoid component damage. If we were rushed, most of us would at least look at that, or potentially face some embarrassment in the debrief, or from maintenance.

Unlike the F-4, there was no battery in the F-15,[3] so nothing came to life until the jet fuel starter (JFS) was running and even its items were limited to only those necessary to safely start the engines (engine instruments, fire warnings, etc.). Starting the JFS was very straightforward; you just made sure the switch was "ON" and pulled the "T"-handle. It discharged an accumulator that spun up the little turbine located between the engines above/aft of the centerline pylon. When the JFS started it made a distinctive wailing noise and when that rising sound leveled off, it was ready to crank an engine. (There was a starter "READY" light, which came on when it was "up to speed," usually within ten seconds of pulling the T-handle.)

The start levers for the engines were located on the front of the throttles, beneath the HOTAS switches and thus required a reach of the fingers to touch and pull. Called "fingerlifts," pulling one up would engage the JFS to that engine and it would spin it up to starting RPM, usually 18 percent. At that point the throttle would be moved up "over the horn" to "IDLE" and the engine instruments (and fire warnings) monitored for a normal and proper engine start. The crescendo of JFS whine and it audibly dropping back to its steady-state idle wail was the sign of successful disengagement and now it was ready to crank the other engine. Normally we started No. 2 first to check its utility hydraulic pump pressure since it was slightly lower (2275psi) than the left (3000psi) and both (actually the higher of the two) were indicated on the same tiny gage (called a "peanut" gage because of its diminutive size).

Once the engines were running at IDLE, the JFS would shut itself off automatically (which we would check by ensuring the READY light was out – by now the engine noise was so loud you couldn't hear the JFS whine to verify it audibly). The canopy would be lowered to check ECS (environmental control system) air flow (more for avionics and electronics cooling, but on a hot day at Luke, Tyndall, Eglin, Tabuk, or PSAB, the cockpit air conditioning was more than welcomed), and the pilot would cycle the EEC switches to exercise the nozzles and it was then time to start setting switches for flight.

Since the F-15 was designed at the outset as a single-seat fighter, McAir went to great pains to reduce the pilot's workload to the minimum possible by automating almost all the aircraft's subsystems so the pilot could concentrate on flying the jet and fighting the enemy. Hence most switches had three positions: "OFF," "ON/AUTO," and "MANUAL/RESET." Naturally it was a quick and easy process to go around the cockpit from left to right and move all the switches to the AUTO position. AUTO engaged that particular subsystem's own little computer to program its activities, relieving the pilot of any need to do so, or even to monitor it. To be sure we'd gotten them all in AUTO, we'd just check the caution light display (called a "tele-light panel") in the lower right corner of the instrument panel and if one of the systems was still showing off, we'd be sure that switch had gotten moved properly. If rushed, as when you'd have to "jump to a spare [jet]" after ground aborting or if you had been assigned one due to a malfunction of some sort, the idea was just to keep moving switches until all the caution lights on the panel went out.

This OFF/AUTO/MANUAL concept worked very well in flight should a particular subsystem fail. If something showed up on the tele-light panel, we would simply cycle the switch from AUTO to OFF or RESET to reengage (ie reboot) the system. If this failed to reset the component, we would just put the switch in MANUAL or OFF and continue flying, usually returning to base. In MANUAL the subsystem's controlling computer was cut out and the system worked in a "degraded mode" for an uneventful recovery to base. In MANUAL, most components' back-up systems gave you essentially "a Big T-38" which most of us had flown recently anyway, so it was no big deal.

More critical to our business was starting the radar and programming the INS. Again McAir had arranged the cockpit for ease of operation by a single pilot member. The subsystems basically fell into two distinct categories: those that you needed to access in flight, and those you needed to program while on the ground. Since it was inconvenient in the midst of a furball to take your right hand off the stick to flick a switch in the cockpit, all those items requiring manipulation in flight – changing radio frequencies, IFF mode/code settings,[4] radar channels and band settings, opening the air-to-air refueling door, etc. – were on the left console so that a short reach by your left (throttle) hand could move them to the right position. Correspondingly those items that required manual actions while still on the ground – starting JFS/engines, checking the oxygen system, activating the internal countermeasures set, adjusting cockpit lighting, and programming the INS – were located on the right console. Until the advent of the digital transfer module (DTM), most of the pilot's time between engine start and taxi was taken up with programming the INS for the mission.

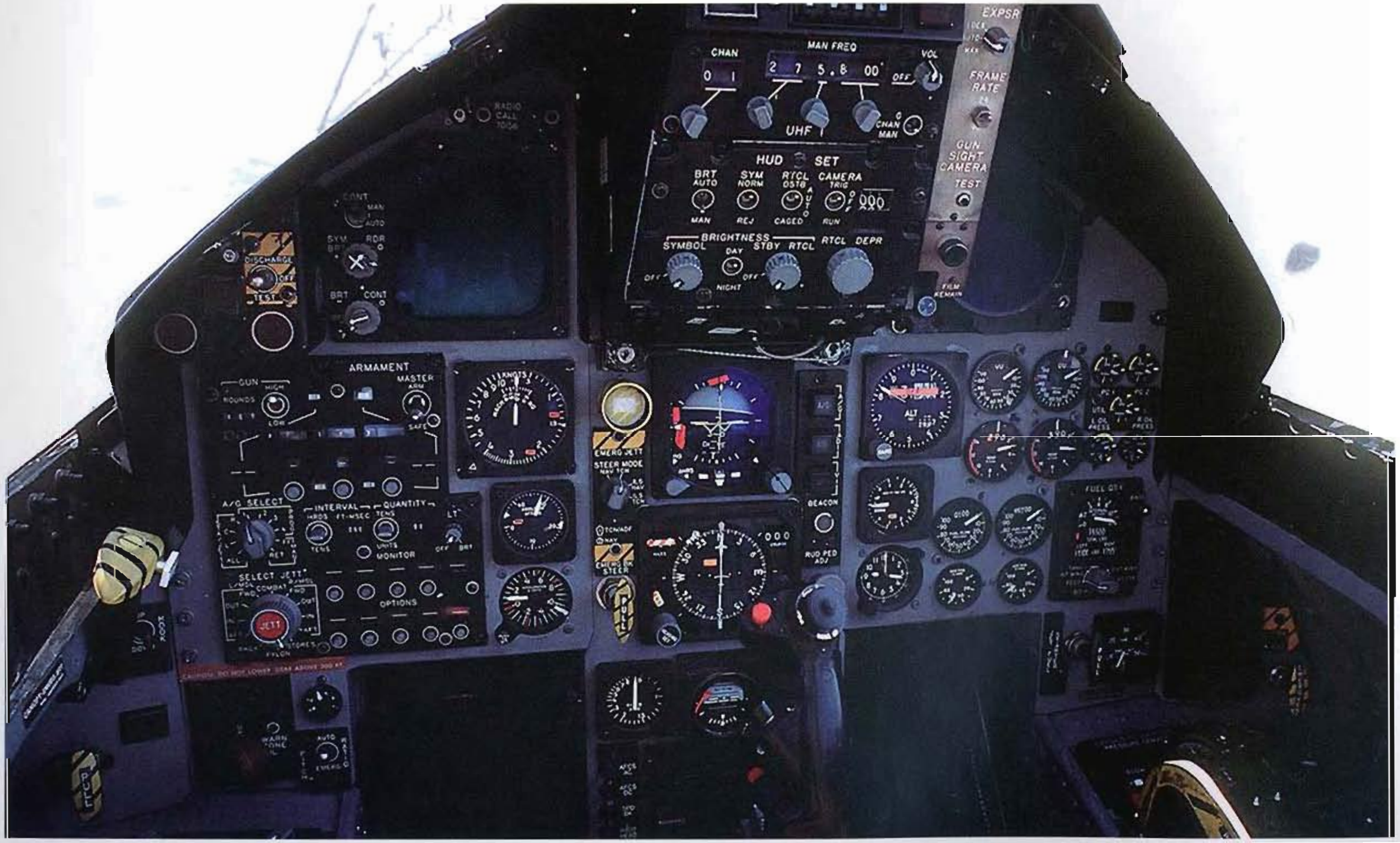
After the INS was programmed, and while waiting for it to align itself, usually a check of the radar's BIT features was called for to ensure that it would work in all the HPRF, MPRF and interleaved modes, and that the tracking data would be stable when locked on. While the radar finished running its BITs and the INS completed its alignments, the pilot moved on to checking those things which actually made the jet fly: the flight controls.

We'd "fan" the speedbrake to be sure it worked, then set the flaps. In another McAir innovation, the flaps had only two settings: UP or DOWN (most jet aircraft of 1950–60s vintage had multiple-position flaps). In fact, in training we were told that the F-15 didn't really need flaps[5] and that originally McAir had designed the jet without them. However, when the engineers at AFSC saw that the design lacked flaps they responded with: "Oh no, the Air Force cannot have an airplane without flaps!" So the McAir engineers put a hinge on the aftmost spar in the wing and made some flaps. Reportedly, the flaps lower the landing (and stalling speed) of the F-15 only 3–5 knots. It was so unnoticeable that if a pilot forgot to lower the flaps for landing he (or she) generally did not realize it until he went to raise the flaps to UP to taxi back to the ramp and found that the flap lever was already there!

However, the most important thing was to be sure that the flight controls were connected properly and that the CAS worked as designed. One of the few flaws in the Eagle, and something it shared with many aircraft, was the possibility that a mechanic could connect the linkages of the flight controls backwards. The long linkage running from beneath the cockpit to the tails was in the form of two identical, long titanium rods. Because it was difficult to see down the long tunnel that they were in, they could be connected properly to the cockpit controls at one end but crossed unseen in the tunnel and connected in reverse to the flight controls. This caused the loss of at least three F-15s and the lives of two great Eagle Drivers.

To ensure that they were connected correctly a flight controls check was made before pulling the chocks. The stick would be pulled back and the pilot looking in the mirror would see the two "barn door"-size stabilators (stabs) kick up in his mirrors. Moving to and pausing in each corner of the cockpit, the pilot would check to see that the stabs and ailerons and rudders would change to the position appropriate for the control input. This would be done twice, a second time after resetting the CAS switches.

The CAS was another (at that time) novel McAir innovation. The F-4 had a terrible propensity to depart controlled flight due to the adverse yaw created by inducing high angle of attack and aileron input in the swept wing fighter. The F-15 eliminated the adverse yaw with the aileron-rudder interconnect (ARI) that kicked in a little rudder (varying as programmed for the airspeed being flown) when the ailerons were deflected, the rudder keeping the nose tracking true while the aileron rolled the aircraft. In addition to the hydraulically powered flight controls, just beneath the stick grip was a stick force sensor which provided electrical commands to the rudder and stabilator actuators. This was called the control augmentation system and it adjusted the stab deflection to give the pilot just what he wanted based on how hard he was pulling on the stick grip. Additionally, it ensured that the rudder and stabs backed up the ailerons for rolling at high AoA or high *g* loadings. At high AoA, the wing's lift was "washed out" by the separation of the boundary layer of air, rendering the ailerons less and less effective as


EXPSR
FRAME RATE
GUN SIGHT CAMERA TEST
CHAN
MAN FREQ
VOL
UHF
HUD SET
BRIGHTNESS
SYMBOL
STBY RTCL
RTCL DEPR
DISCHARGE
TEST
ARMAMENT
MASTER ARM
SAFE
A/G SELECT
INTERVAL
QUANTITY
MONITOR
SELECT JETT
JETT
OPTIONS
BEACON
FUEL QTY
PULL

BELOW
The "front office" of the F-15A. Note the ancient 8mm gun camera film controls (silver vertical panel to the right of the HUD and Main UHF controls), which predated VCR tape recorders. Radar scope (VSD) is to the left, RWR to the right. Note the proximity of the landing gear handle (lower left) to the red Jettison button, which, if not careful, could be pushed in by your thumb (or a pencil in your left hand) when raising the gear. Also note the two engine fire light/shutoff buttons in the upper left that were occasionally depressed (shutting down the engine!) when pilots grabbed the left glare shield edge to push/twist to the right to maintain a tallyho on some bandit sliding into the six o'clock. (USAF)

airspeed decreased as it usually did in a hard turning fight. The CAS compensated for this by deflecting the stabs in opposite directions when the pilot was trying to roll under high AoA load, giving the aircraft a "corkscrewing" effect through the air, allowing the jet to be rolled quickly under *g*, with no worries about departing controlled flight while doing so.[7]

After starting the engines, firing up the radar and INS, turning on the systems and checking the flight controls, it was time to taxi out for take-off. The P&W F100s were powerful motors and even at "IDLE" on the ground they produced significant amounts of thrust. Care had to be taken over which way you swung the tails and the power setting when you did so, because many an Eagle Driver has blown over a security police checkpoint hut, or a maintenance person (or in one case, the windows out of an automobile) by overzealous use of the throttles. In fact, once the jet was rolling, on flat concrete, an occasional pump on the brakes was needed to keep the taxi speed under control.

At the "last chance" (also known as EOR, for "end of runway") area, maintenance personnel inspected the jets for any leaks, tire cuts or other abnormalities, armed the missiles and watched while

So-To-Speak

A recent study showed that American males from 15 to 26 years of age think of sex once every 52 seconds. For American fighter pilots it must be twice that frequency. Consequently, seemingly everything about flying fighters – from "heat seeking missiles" to "put the dot in the ASE circle hole and shoot" – has a sexual connotation. This was all well and good until women began to show up in tactical debriefs. It began, reportedly, when female AWACS controllers first attended a particular *Red Flag* mission debrief. When the first mission debriefer took the stage, he began by saying something like: "The Wild Weasels started at the head of the package…" at which point a group of lusty pilots down front (reputedly from a visiting ANG unit) yelled in raucous chorus, "Head? Head! Who said 'head'? I'll take some of that! Don't say it unless you mean it!" From that point on the US Air Force sold its soul to purchase large quantities of political correctness and ran scared from potential sexual harassment lawsuits.

However, in the usual exaggerated fighter pilot response to unwanted HHQs' (higher headquarters) directives forbidding such references to human sexuality, the fighter force began to develop their own lexicon of substitute words and phrases. Ostensibly intended to avoid even the hint of sexual impropriety and conform to the very letter of the law, the substitute words, phrases and qualifiers only drew stark attention to the word at hand (so to speak), their possible sexual meaning and the fact they'd been used at all. In other words, without the use of hyperbolic substitutes, the reference would have otherwise gone totally unnoticed. Some of the more common substitutes are:

Real word:	**Fighter pilot substitute:**	**Meaning:**
Ahead	Acranium	To move in front of something
Box	Container	A box
Came or Come	Arrived or arrive	To arrive at some place
Head	Cranium, skull, or noggin	The top of something
Heading	Skulling	To go in a certain direction
Job	J-O-B (spelt out)	Function, or occupation
Period	Period, dot	The end of sentence, full stop
Seeker head	Seeker Noggin	The part of an IR missile that sees the target
Warhead	Warcranium	The part of a missile that blows up

There are some words or phrases which immediately conjure up a sexual image if they are not immediately qualified to ensure that, in context, they are not misconstrued by the listener. In these cases the self-respecting fighter pilot has the verbal equivalent of a wild card to keep him out of trouble: so-to-speak. In writings, as is occasionally observed in this book, it is qualified by its initials in brackets (sts). For example, a person might be referred to as being an "upstanding member (sts) of his community."

the pilot did another flight control check. Once they were clear the radar was turned on, the ejection seat armed, take-off trim checked, and we were ready to go.

Lined up on the runway for take-off, the engines were run up to 80 percent rpm (revolutions per minute) to check that they were operating normally at a higher power setting. Previous jets ran the engines up to "MIL" (military, or 100 percent rpm) power for this check, but the F100s were so powerful the F-15's brakes could not hold it above 80 percent and it would begin to slide down the runway. If everything was "in the green" on the engine gages, we'd release brakes and begin to roll. While second generation jets such as the F-4 and T-38 required afterburner for take-off, the F-15 did not. Because it took some time to spin up the huge, heavy turbofans and get them to begin to add thrust to that produced by the core engines, acceleration at first (in MIL) was not particularly exciting, the jet accelerating smoothly through the rotation speed of 120 knots. By bringing the stick back about halfway the nose would come up to 10 degrees (done looking through the HUD). You'd feel the lift-off and raise the gear and flaps. (In yet another McAir innovation the flaps had a "blow up" feature so that if the pilot forgot to raise them, or missed the lever, they would be forced into the UP position by the airstream. Some F-15 pilots didn't realize they'd forgotten to raise the flaps until on final, when they went to lower them for landing and found the flap lever still in the "DOWN" position.)

The F-15 was truly well engineered by its McAir designers. For example, the radar control panel (RCP), set just outboard of the throttles, had a myriad of knobs (sts), each with a different function. One might be round, another knurled, another three-sided, another X-shaped. This was so the Eagle Driver, by memorizing the shape of the knob, could adjust the mode (LRS, SRS, Velocity Search, Pulse, etc.), special modes, frame store, elevation (bar) scan (these things were not originally adjustable on the scope using the TDC button) and other functions without having to look down to see what knob

Also, numerical values are subject to the same consideration as certain words. Thus any arbitrary, made-up or random numerical value is always given as a combination of "6" and "9," in that order, such as "it's about 69 miles away," "It takes about 6.9 seconds," "We have enough gas for six to nine touch and gos," "I have about five hundred and 69 hours in the jet."

Additionally, shortly afterwards there arrived from Nellis, the seat of all fighter knowledge and mecca of all American land-based fighter pilots, disciples of the un-word whose duty it was to focus the brethren (and sistern when they arrived) of the fighter squadron strictly, solely, and completely upon weapons and tactics. These disciples were known as Weapons Officers, graduates of the FWIC/WIC, and to keep the squadron members (sts) focused on the j-o-b at hand (sts) they required absolute abstinence from any word which might prove a temptation or distraction from flying fighters and killing MiGs. Such temptations included the lure of the high-paying airline j-o-b or the flying clubiness of a Guard j-o-b. Unacceptable distractions to a proper fighter pilot career were things like staff j-o-bs or "professional military education schools." Worst of all for an air-to-air unit, whose sole purpose for existence was to kill MiGs, was the utterance of the b-word. If such subjects must be addressed in the course of conversation, the disciples ordained that they could only be addressed by an oblique reference, such as:

Subject	**WIC Approved Reference:**
Airline	Seven letter A-word
Bomb	Never, ever said by Eagle pilots. Usually "B-word" is substituted instead
Guard	"G-word," for the mass-exodus to the ANG that took place in the 1990s
Wife	"Frow" (for "frau"), or CINCHOUSE
School (ACSC, AWC, etc.)	Seven-letter S-word
Staff	Five-letter S-word

Failure to follow these guidelines would result in the fine of one dollar if said during a flight briefing or debriefing. In the squadron bar, or officers' club, the offender would have to buy a round of drinks for all present.

he had in his hand (sts). Hours were spent in the squadron's cockpit procedures trainer (CPT) practicing reaching for a specific knob. Before the first (solo) intercept training mission, the IP tested the student's tactile memory by calling out certain knobs and directing setting changes. The student had to be able to accurately locate the proper knob and make the directed adjustment. This was known as the "touch test" or "blindfold test" and the student was allowed only one mistake. Successful completion of this test enabled him to go on his first intercept training mission knowing where to reach for the right knob without having to look down.

This was also important during rejoins after take-off. When taking off individually (five second spacing) and rejoining to fingertip (close) formation, the wingman was required to narrow the azimuth scan to 20 degrees (settable only on the RCP) and position it down and away from the flight leader (with the TDC) so as not to radiate the IP with high powered electrons from the APG-63. Early on there was serious concern that this caused cancer and several F-15 pilots are known to have battled testicular cancer during their careers, probably because of it.

Another McAir innovation – actually an "invention" – was the Vmax switch. Located on the left cockpit sidewall just outboard of the throttles, a switch was covered with a red plastic guard that was safety-wired in the down, closed and OFF position. The Vmax switch was provided because of the initial AFSC requirement for the jet to reach 2.5 Mach. However, at 2.3 Mach bad things began to happen: the windscreen began to overheat and melt, threatening to cave in under the excessive airstream pressures, the engine intakes began to have a disturbing harmonic vibration as the massive volume of air built up and sonic pressure waves came together (sts), and the F100 engines required a fuel mixture so rich that they literally would burn themselves out attempting to push the aircraft at the required speed for long durations. Consequently, the AF wisely decided that the 2.5 Mach requirement was not that critical after all. However, should it ever be needed the capability to enrich the fuel mixture to the F100s was provided with the Vmax switch. Breaking the safety wire, raising the guard and flipping the switch (above Mach 1.1) would increase the fuel flow by 4 percent to the engine core and afterburner to generate 2 percent more rpm and raise the FTIT by 22°C. The thrust increase would also be approximately 4 percent. While not enough to help you escape a "Flogger" trying to run you down or separate from a furball with a "Fishbed," it would provide the extra "umph" to get high and fast and get to the "Foxbat" using the high-fast flyer profile. Thus, its tactical utility was very limited and use of it was restricted to six minutes on each occasion (the time it took for the windscreen to melt and begin to sag inwards), and 60 minutes overall (the time it took to burn out the core of the engine). It was never used in training, just activated in the simulator during the high-fast flyer intercept profile.

FLYING THE "MOST POWERFUL FIGHTER KNOWN TO MAN"[8]

The Eagle was a dream to fly. With the large cambered wing it was both stable and responsive. This was intentional because McAir (and the Air Force) wanted the pilot not to have to worry about flying the jet while he was working the radar looking for, and launching missiles against, adversary aircraft. In that way, the F-15

RIGHT
Demonstrating just how good the Eagle looks on the ground or in the air, a couple of Luke Eagles wait on the ramp for DACT training with F-16s. F-15A 76-078 became a 550th "Silver Eagles" training jet after a brief stint with the 49th TFW's 7th TFS "Bunyaps." In 2006 it was on strength with the 110th FS Missouri ANG. (Warren Thompson via Doug Dildy)

was as stable as a Cessna, the nose staying just where the pilot put it while he looked away to work the radar. The flight controls were "neutral" so that no stick pressures were exerted at 1*g* and the same amount of stick deflection produced the same amount of *g* (increasing AoA) at any airspeed. Thus the perceived resistance to pulling on the stick was the same (to get the same *g*-loading) whether you were maneuvering at the merge at 450 knots or had slowed to 250 knots. This capability helped the pilots "program" or "condition" their "pulls" (muscle memory) to be consistent for the same *g* regardless of airspeed. After only a few basic fighter maneuver (BFM) engagements you generally knew what point to pull the stick to in order to get the desired *g* (usually the maximum allowable).

The F100 turbofans were awesome in afterburner (although some care had to be taken lighting the A/Bs and manipulating the throttles with the "burners cooking"), but getting or being slow complicated their use and compromised their performance. On one of the RTU training missions in the early days, DACT and "shooting the dart" included a comparison of the acceleration capabilities of the F-4 Phantom and the F-15 Eagle. We would join up on the Phantom at 250 knots and once in the work airspace, the IP would give the signal and both pilots would plug-in the afterburners. The F-4's J79s lit right away and the Phantom would immediately begin to move out in front in an old fashioned drag race. The F100s' A/Bs would light, but because of the low airflow through the fan section, thrust would not be dramatically increased at first. As with take-off, once the airflow through the turbofan increased, the acceleration not only picked up but the rate of acceleration accelerated exponentially, with the Eagle passing through 300 knots, then 350 knots, passing the F-4, and blowing through 400 knots with mounting rapidity. This phenomenon was known as "the faster you go, the faster you go faster."

So the trick was – once maneuvering began – to stay fast and only slow down when you were ready to make the kill. The instantaneous "corner velocity" (simply said, the quickest, tightest turn of a fighter) for the F-15A at a combat load (half fuel and all the missiles) was given as 385 knots at medium altitude (10–20,000ft) and would generate about 15 degrees per second turn rate. In other words, at 385 knots and maximum *g* (7.33 at the time), the F-15 could turn a full 360 degrees in 24 seconds, about half the time and two-thirds the turn radius of an F-4. However, at this airspeed maximum *g* also generated so much induced drag[9] that even with the "burners cooking," airspeed would deteriorate. You could feel this in the stick if you flew it with your fingertips: first a subtle rumble, then a more generous rumbling. As airspeed dropped (and you hung onto the stick in its maximum *g* position) the airframe would begin to shake in a shuddering manner and it would take on an increasing amplitude/decreasing frequency as airspeed decreased. (With the stick full back "in your lap" and the airspeed decelerating through 250 knots it felt like elephants were dancing on your wings.) Thus the airplane continually "talked to you" about its airspeed, especially as it decayed through 250 knots. At that point the turn rate fell off dramatically and the turn radius opened up widely, making the Eagle "a grape" (ripe for the picking) for any adversary with better performance at that moment.

The HUD was an excellent tool to help fine tune airspeed control. A quick glance at the HUD – and not having to look down into the cockpit to the airspeed indicator – would confirm what the jet was telling you with its airframe buffet. Specific markers were looked for: 425 knots, 385 knots, 350, 300, 250, etc. At 350, if you didn't do something to stop the airspeed decay, such as lessening the *g*/AoA, the loss of knots continued with the rush of a waterfall off the wings. One solution was to roll the aircraft more inverted and use gravity ("God's *g*") to help turn the aircraft tighter and the descent would give respite to the unwinding airspeed indicator… at least momentarily. At the bottom there was always a "pull out" required and this needed to be planned to put you in the killing position, because you'd be cashing in the rest of your knots to get there, so you'd best bet correctly.

The preferred solution to the problem, however, was known as sustained corner velocity. This is a higher airspeed – approximately 425 knots for an F-15A at combat weight – in which the thrust produced by the engines (recalling that the faster an afterburning turbofan goes, the more thrust it produces) exceeds the induced drag generated by the *g*/AoA. Because it is a higher speed, the turning circle is slightly larger and the rate at which the F-15 goes around it (turn rate) is correspondingly reduced to about 12.5 degrees per second. The good news, however, is that because the thrust to drag ratio is 1:1 (or better in some cases) this performance can be sustained until we run out of fuel (or by our human body's ability to sustain 7.33 – or now 9 – *gs*). Thus an F-15 flying at 385 knots meeting at the merge another one flying at 425 knots will have an initial turn rate/radius advantage, but as its airspeed deteriorates, it slows down and widens its turn allowing the now superior-performing Eagle to progressively move into a shooting position by going around the now smaller turning circle faster than its decelerating adversary. This is the heart of John Boyd's "energy maneuvering" concepts and the main BFM lesson taught repeatedly at Luke and, later, Tyndall.

In almost all regards, in maneuvering flight the F-15 was a very safe and forgiving jet fighter. The exception to that was when it had a lateral weight imbalance. This was usually caused by the two internal wing fuel tanks not feeding at the same rate (due to differing fuel pump flow pressures, fuel pump failure, or a prolonged turning engagement in one direction – in this case the "high wing" would feed more since it had gravity helping the pump in that wing pass gas to the fuselage tanks while the "low wing"'s pump had to fight gravity and its flow was somewhat reduced). With the heavy M61A1 20mm in the right wing root, an imbalance was already built into the jet and it only took about 200lb of fuel in that wing to make the imbalance critical. At that point, as the AoA limits of the wing were approached, one side would stall out and flip the jet abruptly and violently into a spin. While normally the jet was very spin resistant, when a fuel imbalance occurred it became spin-happy and would do so viciously and show no interest in coming out of it. For this reason there was a requirement to check our fuel state – specifically looking for a fuel balance between the wings of within 200lb – before beginning each and every engagement.

"A 'Lima' in the Lips:" The AIM-9L Sidewinder

The IR-guided AIM-9 Sidewinder was one of the simplest of the early generation of US air-to-air missiles. Originally designed by the Naval Ordnance Test Station (NOTS – later known as the Naval Weapons Center) at NAS China Lake, California, in 1950–52, it was built by GE and Ford Aerospace (Philco) and adopted by the USAF in 1956. Its heat-seeking sensor (a lead-sulfide PbS photo-electric cell) provided data that drove a set of delta-shaped canards that initially overcontrolled it, giving it a characteristic snaking flight path as it left the launching rail and earning it the nickname "Sidewinder," after the vicious rattlesnake of the southwest American desert.

However, the earliest operational variants, the AIM-9B/D/E/G, were anything but vicious. These experienced a disappointing record in SEA: 454 firings resulting in only 81 kills over NVN aircraft, a 17.8 percent effectiveness,[10] not even twice that of the far more complex radar-guided AIM-7. Incorporating changes from combat experience, improvements were made resulting in the faster, longer ranged and more maneuverable AIM-9J/P (the "P" being originally intended as an improved "J" for export) which began production in 1972. However, the missile's chief limitation was that the shooter had to maneuver to a rather restricted "vulnerable cone" of about 30 degrees off the target's tail for the missile to work properly. At higher (known as "aspect angle") angles off the tail, the IR seeker could not see the heat source because it was not looking up the tailpipe into the jet engine and the fuse was not quick enough to detonate the small 10lb warhead unless it was overtaking from the rear, as opposed to passing at extremely high angles and velocities.

Simultaneously the Air Force was developing the AIM-82A, a proposed front-aspect 50 degrees off-boresight heat-seeking missile, for the F-15, issuing an RFP for development in February 1970. However, the DoD canceled this effort on August 27, 1970, ordering the USAF to adopt the AIM-95 being developed by the Navy for the F-14. Meanwhile, Raytheon proposed a much cheaper way of obtaining the desired capabilities by modifying the Sidewinder with a new cooled seeker head and laser fusing. On June 8, 1971 the two services signed a joint agreement to develop the AIM-9L for both the Tomcat and Eagle.

The 191lb AIM-9L, known as the "Lima," consisted of four components: guidance, fuse, warhead and rocket motor. The most noteworthy advance was the development of the high-discrimination Indium Antimonide (InSb) seeker head which could "see" the heat of a jet engine through the aircraft skin even with a warm (ground, sunlit

We lost several F-15s due to this problem. In fact, after midair collisions it was the second greatest cause of F-15 losses. It was almost always caused by the pilot not noticing a fuel imbalance developing because he was rushing to set up the next engagement and not waste precious training fuel "just driving around" and thus might give "lip service" to the required fuel balance check. This was largely driven by the emphasis to maximize training experience because the enemy (the Soviet MiG drivers) were seen as such formidable foes, and several of these otherwise excellent Eagle Drivers paid for the error with their lives when they tried to save a jet that was bent on falling to the ground in a spin, taking them with it.

The physical demands of high-*g* BFM were completely draining on the new Eagle Drivers. The hard breathing under high-*g* loading – sucking in a breath and holding it, explosive exhalations and rebreathing – twisting in the cockpit to look back over your shoulder when your head weighed seven times its normal mass, weighted arms supporting hands manipulating stick and throttles under heavy loads, abdominal and thigh muscles clenched to try to hold the blood in the upper torso, and especially your brain, all of it was both invigorating and tiresome work. Perspiration soaked through the flight suit until it was wringing wet, even through the fabric of the *g*-suit. Small capillaries in the undersides of the arms would swell to the point of bursting, creating splotches like an outbreak of the measles. These were called "geasles" and were generally worn as a badge of honor for a hard fought BFM engagement. (In defiance of TAC/ACC dress and appearance regulations, many of us wore our flight suit sleeves pushed up above the elbows to show off our "geasles.")

Training at Luke, and later Tyndall, taught three basic things: how to fly the jet and be pilot-qualified (P-Qual) as an F-15 pilot,

cloud tops, etc.) background. This was enabled by cooling the InSb seeker by 5,000psi of argon from a softball-size bottle (TMU-72/B) inserted into the guidance and control unit (GCU) section.[11] The AN/DSN-29 solid state GCU was powered by electricity from a gas grain generator, which also drove the long-span double-delta canards using proportional pursuit logic. This caused the missile to actually pull "lead" on the target rather than fly pure pursuit (continually point at the target) or slide (lag) into a "tail chase." By doing so the missile "cuts off" the target, increasing its effective range and optimizing the intercept geometry to optimize the active optical target detector fuzing.

The secret of the DSU-15/B proximity fuse was its laser technology, which used four IR emitters located just behind the canards. Each of these was paired with a similar detector window. The beam was transmitted in about a 45-degree forward angle in order to detect the target before passing it. The 20.8lb Argotech WDU-17/B annular blast-fragmentation warhead was composed of spirally wound spring steel filled with 8lb of PBXN-3 tritonol. The warhead was armed by five seconds of 20g acceleration and was detonated at the rapid rise of reflected laser energy. Thus the warhead was triggered by the approach of the target rather than by passage of it. This was backed up by a contact fuse.

The Hercules/Bermite Mk 36 was a reduced-smoke, solid-fuel rocket motor which accelerated the missile up to 2.5 Mach above the speed of the launching aircraft. Mounted at the nozzle end of the motor were four large fixed fins, each fitted with a rolleron for stabilization. This simple device featured a ram-air-spun wheel which acted as a gyroscope that deflected the device into the airstream to correct the missile back to its launch orientation. Because the seeker head tracked its target through a nutating (spinning) motion, it would lose the direction of motion if the missile fuselage was rolling about in the air.

While the Lima was composed of a series of sophisticated components, they worked together in simple functions. Consequently, testing the Lima in 1978–82 showed that its reliability was greatly improved over the earlier versions, with an 80 percent effectiveness giving it a virtual one-shot-one-kill and short-range fire-and-forget capability, as Argentine (vs the British) and Syrian (vs the Israelis) pilots soon discovered. With the Lima on the Eagle, the F-15 became a two-kill prior to the merge air superiority fighter. As Eagle Drivers said to their opponents during DACT: "If you come straight down the snot locker nose on I will shoot two Sparrows at you and call you dead. If I am out of Sparrows I will rip your lips off with a Lima before you can get to the merge. Questions?"[12]

basic intercept principles and techniques, and BFM. Although much more was instructed, the RTU's primary job was to train an Eagle Driver to fly the airplane, and intercept an enemy and kill him (by BFMing to a gun or AIM-9 attack). In the early days BFM was taught to arrive in the rather restricted "stern only" AIM-9P weapons engagement zone (WEZ), a 30–45 degree around the tail of the adversary aircraft, or, if the enemy denied that by turning hard into the missile attack, to close for a gun shot. In the mid-to-late 1970s it was at the operational unit that the training stepped up to qualify the new Eagle Driver as mission ready (MR) to fly and fight as a wingman in a two- or four-ship mission against enemy formations. It was also at the operational units that the new Eagle Driver learned about the ICS[13] and the newest arrow in the Eagle's quiver, the all-aspect AIM-9L. While initially thought by the program managers to eliminate BFM, it only made the BFM begin at much longer ranges.

LIFE IN AN EAGLE SQUADRON

Being in an F-15 squadron was like being in the Boy Scouts only without the adult supervision. You can't gather a bunch of young, aggressive, high-energy, goal-oriented Type A personalities into a single group and not have a recipe for both a dynamic killing organization and one whose non-flying shenanigans are fraught with all manner of excesses. Fighter pilots historically, even from the earliest days of WWI, have been stridently individualistic, even arrogant, and fiercely independent. This is especially true of the pilots of single-seat fighters because their life in the air is "kill or be killed" and this depends almost entirely upon their own individual abilities. Only the results matter, how you get them is up to you – your proficiency, your skill, your imagination and your innovation. A common fighter pilot statement is "if you're not cheating, you're not trying."[14]

Air-to-air training was incredibly intense, the results indisputable and the risks of getting killed very real. Looking back on the experience, sometimes this author feels that we tried too hard. Intel presented the Soviet foe as "10 feet tall and bullet proof" and we strove ardently, sometimes violently, to reach that same standard. At Birburg's 36th TFW, on the frontlines of freedom in the Cold War facing the Soviets and outnumbered 2:1 by their MiGs, we often pushed ourselves, our wingmen and our jets to the limits of capabilities or endurance. In the initial cadre of the 36th TFW (1977 through 1981) we lost eleven F-15s, several of them with their pilots. Some of these loses were due to the mechanical idiosyncrasies of the jet[15] initially being learned under the stresses of air-to-air combat training, but others were due to spatial disorientation, g-induced loss of consciousness (G-LOC), spins caused by fuel imbalances, and midair collisions. The all-consuming desire to be the best we could be – and certainly be better than our potential adversaries – underscored the intensity of our training in each of us, sadly to the point where we killed some very good men. It is to these men in general, and two in particular, that this book is dedicated.

There are a few common and remarkable traits that tend to make up the most successful fighter pilots. These are men and women who are intensely motivated, aggressive self-starters who have the ability to recognize "what needs to be done" and the willingness to do it, even without – or especially without – supervision. These factors are valued in the air because they result in quick kills and survival, and are usually also appreciated on the ground by squadron and wing leadership. Initiative is highly prized and calculated risk-taking is accepted as part of the "cost of doing business." Whereas the oppressive top-down decision-making in SAC resulted in a "Mother may I?" mentality among aircrews, in fighters the adage was to go ahead and do whatever was thought needed to be done, because waiting for approval might result in a missed opportunity. Besides, it was often said, "it was easier to get forgiveness than it was to get permission."

However, the individual initiative, focused aggressiveness and fierce independence which were so highly regarded on the ground and so finely honed in the air, could lead to insensitivity to feelings, manifestations of superiority, scoffing at buffoonery, and indifference to authority. When it comes to an Air Force or Command regulation that is deemed silly, frivolous or superfluous, we have what's known as the "selective non-compliance." That is to say that ground regulations and directives[16] that are viewed as petty and have no basis in common sense are casually ignored. These generally include uniform guidelines ("ohmigod" we can't have white socks under our flight suits when the regs specify black or navy blue), carrying unneeded checklists solely for the sake of appearances, and the like. In this regard, the F-15 fighter pilots were normally seen as free-ranging "cowboys" and the job of an Eagle squadron commander as that of "herding cats."

While seemingly cavalier and insensitive on the ground, in the air F-15 pilots are almost universally deadly serious about their flying and there is no tolerance for any misstep or buffoonery in flying the jet. The most heinous examples would incite flaming acid-lipped debrief, and sometimes be underscored with an embarrassingly hysterically hilarious recounting at the Friday afternoon squadron "beer call."[17] Despite the extent to which we prided ourselves on being perfectionists in pursuit of our air superiority skills, there occasionally would be cause for a laugh. For instance, there was one time when a Stateside squadron did a complete "load out" (loading four live AIM-7s, four AIM-9s and 940 rounds of HEI, high explosive incendiary bullets) and deployment launch as if heading en masse to a forward base to begin combat operations. The route of flight, after

BELOW
The AIM-9L and M provided the F-15 with its first true front-aspect single-shot kill capability. This allowed the Eagle Driver to target one adversary with his AIM-7F Sparrow and upon acquiring another bandit visually, destroy it with a "Lima in the Lips." The "Mike," shown here, incorporated flare-rejection capability. (USAF)

"A Rose by Any Other Name is... A 'Logger,' or a 'Tonka,' or a 'Stinky'"

One of the hallmarks of fighter pilots is the individual "tactical callsign" or nickname. This is not just a manifestation of the stereotypical fighter pilot bravado, but became an institution during the air war in SEA because the stresses of combat – being shot at by MiGs and SAMs and AAA – often stretched a pilot's mental abilities to the point where it inhibited recognition of the arbitrarily assigned callsign for that mission. While it became difficult in these life-or-death situations to remember if today you were to be called CHEVY or FORD, or whether you were TWO, THREE or FOUR, you always knew who you were. More importantly, the flight member who saw the missile or the MiG approaching and needed to tell you to "Break!" knew who you were, even if he couldn't remember your assigned flight callsign. It was much easier to say "'Disco,' break right, MiG at six..." than it was to remember and say, "BUICK THREE..." Consequently, individual tactical callsigns for each pilot came into being.

With the advent of the F-15, the volume of radio communications required to exchange targeting information, ensure a good sort and direct the engagement in – and disengagement from – a "furball" made the tac callsign even more vital. While the use of tac callsigns airborne was discouraged by "mother TAC,"[18] it flourished in the overseas commands. In USAFE, this was because the NATO callsign system generated a cumbersome double alpha, double numeric radio callsign for use with GCI. For example, at Bitburg it was "Lima Alpha (and a two digit number)" and at Soesterberg it was "Alpha Kilo (plus two digits)," altogether too long and unusable in a fast-flowing, hard-turning fight. So these NATO callsigns were used in the Main UHF for talking with GCI, and our individual tac callsign was used in the second, or Aux radio for interflight communications in the fight: "'Disco' tally both, 'Dallas' take the high guy to the right, I'm engaged on the low left Viper..." Imagine the mouthful of syllables that had to be spewed out if "Dallas" were flying as "LIMA ALPHA SEVEN TWO."

To be effective a tac callsign needed to be short (no more than two syllables), distinctive (could not be a word commonly used in flight such as "Fox" or "Guns," etc.) and memorable. They were normally selected by the squadron and bestowed upon the individual during the sacrosanct MR (also called a "naming") Ceremony and chosen more for the ability of the other members of the squadron to recall instantly (especially in the intensity of a fight) than for any other reason. It was "how they knew you." Consequently there were three broad categories (and many exceptions to these guidelines) of how the squadron came up with a "handle" to remember and call you by.

The first category was if you had highlighted yourself by committing some heinous or hilarious error during your MR training. For example, a new pilot at Bitburg had completed all the requirements of his MR check ride when he led the check pilot back to base and after an instrument approach he "pitched out" to land, his check pilot delaying a few seconds to take spacing for landing. Rolling out alongside the runway and breathing a sign of relief that it was finally over (and thus far all had gone well), he reached up to grab and lower the landing gear handle and the pencil he held in his left hand (he was left handed and had been using it to write down frequencies and other data during the instrument approaches) pushed the red "JETTISON" button located just above the gear handle. There was a loud "thunk" and the external fuel tank dutifully dropped from the centerline pylon and fell into the fuel tank storage area near the base perimeter. The good news was that he had returned the tank to where it had come from... The bad news was that after hitting the ground it was no longer useable again. Thereafter he was known as "Tank" – no one could forget that episode.

A more common tac callsign arose if a pilot went over the Mach during training in subsonic airspace. He might be tagged as "Boomer," especially if there were complaints about the noise (or broken windows) from the local populace. More specific to the F-15 was the fact that after landing we were to pull the nose up to 12 degrees on the roll out, putting the maximum frontal area into the wind in what was known as the "aerobrake" to slow the aircraft to taxi speed (the F-15 needed no braking parachute). At 14 degrees of pitch the HUD started flashing, indicating "too high, too high;" for at 15 degrees or so the tips of the two tail booms mounting the stabilators would be dragged on the runway pavement and ground down considerably. New Eagle Drivers who were overzealous in their aerobrakes and damaged the tail cones might become "Tips" or "Grinder."

A second category, if the squadron did not have some embarrassing episode to pin on you, would be related to the new pilot's physical appearance. A particularly large guy might be (as big as) a "Bus" or a "Lurch" (the Frankenstein-like butler in the TV show *The Addams Family*) or a "Jumbo." Someone who resembled the *Star Wars* movie character "Yoda" would become, of course, "Yoda." One who resembled actor Peter Sellers' "Inspector Clouseau" character was named "Kluso." USAF Academy football player and now Hawaii ANG F-15 pilot Matt "Boz" Beals was so named because of his uncanny resemblance to the American collegiate and professional football star (and actor in the action movie *Stone Cold*) Brian Bosworth. "OP" Denney looks like a grown up version of "Opie" (a child actor, now movie director Ron Howard), Andy Griffith's son on the TV series *Mayberry RFD*.

The third general category – if you made no bone-cranium errors in training and had no distinguishing physical features – would be a play on your name. Hence we have "Lava" Moulton (saying the words in reverse order makes it make sense), "Taco" Bell (in fact we have at least a half dozen "Taco" Bells), "Dusty" Rhoades, "Corn" Hruska (think "Husker"), "Muddy" Watrous, "Cheese" Graeter, "Cherry" Pitts, "Gigs" (as in "Giggles") Hehemann, and "Mole" Underhill. One of the more difficult to decipher might be "Kimo" Schiavi who was named after the phrase "Kemo Sabe," the title (reportedly meaning "Trusted Friend") that "Tonto," the Indian sidekick, used to call the "Lone Ranger," in a 1960s' TV western of the same name.

While there are many tac callsigns that do not figure into any of these three broad categories – such as "Skeet" Frasier, "Magic" Beesley, "Log" Randolph, "Boa" Straight, "Dallas" Thompson, "Vegas" Cox, "Rowdy" Lewis – most do. And knowing this it may be easier to divine the origin of an Eagle Driver's tac callsign as you see others mentioned in this book. Where does "Disco" come from? It'll take a few beers or half a bottle of Jeremiah Weed before that story comes out!

several air-to-air refuelings, took the formation (a string of four ships) out over the Pacific Ocean before turning back and landing. At a certain point out over the Pacific one of the new Eagle Drivers decided on his own to simulate "crossing the fence" (entering "bad guy territory") and moved the master arm switch to ARM. Toying with the pickle button atop the stick, he inadvertently shot off an AIM-9. The whoosh! of the missile rocketing off the rail beside him made him flinch and he pushed the pickle button again and a second Sidewinder followed the first out into the Pacific Ocean. Obviously this was an event that could not be concealed. Afterwards the pilot, who will remain nameless but has been introduced in this book before, was renamed "Two Shot" in honor of his $250,000 buffoonery.

DACT: A SUBJECTIVE COMPARISON OF CONTEMPORARY FIGHTERS

Since the mission of the F-15 and the men (and now women) who flew it was air superiority – the efficient, remorseless killing of any aircraft that dared stand in our way – we took great pains to know our potential foes very well, to learn their weaknesses, know how to combat them, and how to survive and live to fight another one. In doing so, the variety of Western fighters provided some basis for emphasizing certain maneuvers and engagement techniques that could be used against Soviet (or other foreign) equipment that had similar capabilities. Thus we were always comparing the Eagle's abilities against those we trained against and those we might have to fight come that day. Below is this author's assessment of the capabilities of those fighters that were flying during the timeframe he flew the F-15.

GRUMMAN F-14A TOMCAT

Sometimes referred to as the "Tomkitty" due to its relatively docile nature compared with the Eagle, it was more commonly known to us Eagle Drivers as the "Turkey." This is because from above and behind the broad back and tailfeathers, the skinny wings sticking out and the long neck (housing its two-member [sts] crew) made it resemble the near-flightless bird which usually shows up on the dinner table for Thanksgiving. The reason this vantage point evoked the Navy fighter's nickname is that it was the one that the F-15 pilot would find himself in most often in a DACT engagement with F-14As, looking down at the "Turkey" from the killing position.

The F-14A was a transitional aircraft, a third generation airframe[19] with third generation avionics and engines. Its radar was the AWG-9, standing for Airborne Weapons Group, a combination of off-the-shelf electrical components cobbled together to make a long-range, pulse/Doppler radar capable of detecting targets approaching to attack the fleet. The AIM-54 Phoenix was specifically developed to be a very long range "bomber destroyer" missile and Hughes made the AWG-9 and AIM-54 capable of multiple target engagements. The AWG-9 did this by using a "spot lighting" technique. That is, the radar would shift its beam from one target to another, highlight and track the new target for a short time, then move on to another; finally (after up to six) it would return to spotlight where its small analog computer calculated the original target would be, update and begin the cycle all over again. In the meantime, if the target had changed its flight path and wasn't in the "spotlight volume" when the AWG-9 looked there, the radar and the AIM-54 assigned to that target went stupid. So in a BVR engagement a mere 30-degree "check turn" and ramp down to a lower altitude was usually enough to break lock and negate the otherwise "dreaded" Phoenix.[20]

By accepting TF30s from the F-111 program the "Turkey" was terminally underpowered as a dogfighter. This was mitigated somewhat, especially for acceleration and top speeds, with the variable geometry (VG) wings. At .9 Mach and above these would be fully swept and in order to maximize lift at lower speeds they were programmed to swing out progressively as airspeed decayed (if the wing sweep switch on the right throttle was in the AUTO position, which was the normal dogfight mode). For the Eagle Driver turning at the merge on an F-14, this became a huge airspeed indicator, the wing swinging like the needle on a dial indicating: "I'm doing Warp 9," "I'm slowing down now," "I'm getting slower..." "... slower...," wings now fully extended almost straight out "I'm out of knots, come on in and shoot me!"

At that point it was no problem for the more powerful and more agile F-15 to swoop in and put the gunsight pipper on the RIO (radar intercept officer) in the back seat and, simulated of course, fire a burst through his helmet, eliminating him from any further inter-cockpit discussions of their situation, then drill the pilot himself.

DACT with F-14s was invariably a viscerally gratifying experience. The fact that the Iranians had 79 of them made us take them seriously in case we ever needed to eliminate the top fighter in the Ayatollah's air force.

DASSAULT MIRAGE F1C

Historically, the Mirage F1C was developed at the very same time as the F-15, becoming operational in 1974. It was a single-engined fighter built around the powerful – but huge and heavy – SNECMA Atar 9K-50 turbojet engine that occupied most of the volume of the airframe. It had small wings and normally carried a single Matra R530 radar missile on the centerline and a pair of Matra 550 Magics on the wingtips. Its Thompson-CSF Cyrano IV radar was pulse/Doppler, in the sense that it could be either pulse (for look up) or Doppler (no range information) in the look-down mode.

The Bitburg Eagle squadrons periodically deployed to Orange in the south of France to train against the F1C RTU, weapons school and operational squadrons based there. The capabilities of the F1C in the air-to-air arena replicated those of the MiG-23 "Flogger" very closely, except of course flat out acceleration and top end speed. The radar was assessed to have similar search and track ranges and the MiG was "given" (by Intel) a depressed angle capability that approximated the Cyrano's look down capability.[21] The R530 was designed as a bomber destroyer missile and the IPs and weapons officers of the unit taught that if they became aware they were encountering enemy fighters instead of bombers, they were to jettison (rather than fire) the big missile.

Nevertheless, the F1C was fast and had strong acceleration. However, its extremely heavy wing loading made it a very poor turning fighter, akin to the "hard-wing" F-4D. One day during a DACT deployment to Orange we flew 20 1 v 1 BFM missions, half with the F-15 starting out defensive, and half with the F-15 on the offensive perch. In the latter the Eagles got in killing shots (two AIM-9s or one full second of tracking gun video) within 180–270 degrees of turn in all ten engagements. In the ten cases where we started off defensive, there were seven instances where the F-15 pilot

ABOVE
The AIM-120 AMRAAM, informally called the "Slammer," provided the mature MSIP F-15C with its most awesome capability: the ability to simultaneously target as many individual adversaries as "Slammers" on board, without tying the radar specifically to any of them. Here the 71st FS "flagship" unleashes an AMRAAM on an unsuspecting target drone during a WSEP shoot. (USAF)

used his jet's superior thrust to weight ratio, turn rate capability and visibility to overshoot the Mirage, reverse roles and gun the F1C. There were two instances of a neutral outcome and in the last a new Eagle Baby learned some valuable lessons.

It perhaps goes without saying that the 2 v 1 (single Eagle) engagements on the second day were much more demanding. This was primarily because the Magic missile (which in several ways was similar to the AA-11 "Archer") was well respected for its high off-boresight capability and its circilinear flight path. The latter sometimes took it outside the turning circle of the defending airplane and just when you thought you had overshot the missile it would complete its arc back towards you and "spear you" in the belly. Consequently much effort was made to stay out of its launch parameters altogether. In offensive set-ups for the F-15, we had to "kill" one Mirage quickly (as in the BFM engagements) before the second could get his nose around to get a lock on with his Magic, and then fight 1 v 1 if we had an advantage, or separate to survive.

On the third day of the training deployment 2 v 2 tactical intercepts to full maneuvering visual combat were flown and due to the limitations of their radar and lack of an effective BVR missile, it was an absolute massacre for the French.

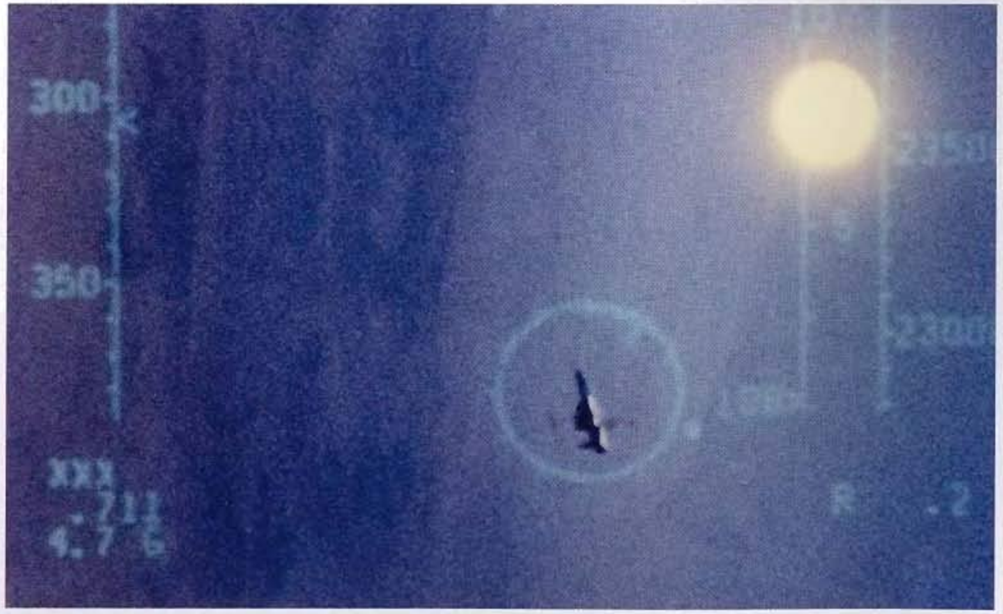
Because of its performance similarities to the MiG-23 and the fact that the Iraqi air force (and others not so friendly to the US) had ample quantities of Mirage F1Cs this was one airplane we studied very thoroughly and we worked hard on BFM and 2 v 2 tactics so as to defeat it consistently.

BRITISH AEROSPACE HARRIER GR.MK 3

The RAF (Royal Air Force) Harrier pilots prided themselves on their VIFFing defensive maneuver. VIFF stood for "vectoring thrust in forward flight" and entailed rotating the variable angle jet nozzles mounted to the sides of the fuselage downward. This would substantially increase the nose (turning) rate of the little "jump jet" for an instant, but we're getting ahead of ourselves.

The RAF Harrier GR.Mk 3s were tremendous ground attack jets and the FAA (Fleet Air Arm) Sea Harriers did an admirable and highly respected job against the Argentines in the Falklands conflict. The GR.Mk 3 lacked radar so it was a visual-only fighter employing the AIM-9L with a fixed (called an "iron" sight). Nevertheless, for DACT we would begin BVR so they could practice defeating radar missiles (we wouldn't call them "dead" on AIM-7 shots), and when we arrived at the merge we were more or less equal since both of us were "slinging Limas" (I'm being kind now, actually they were never equal to us).

The Harriers invariably took the "low block" of altitudes since their engine performance was better where the air was thicker (they had no afterburners). This preference resulted in the Harrier's high-mounted wing masking its hot exhausts and while the Harrier pilot rarely spotted us arriving at the merge in time to shoot an AIM-9L, we were usually denied a pre-merge AIM-9L kill because of the wing/exhaust arrangement. Immediately a turning fight would ensue with the Eagle using its power and turn capabilities to twist in the vertical, pirouette and descend into the guns envelope.



BELOW
"Guns Tracking Kill the F-5 in the descending left-hand turn!" High over the Nevada desert during a *Red Flag* exercise, the co-author eliminates one of the aggressors from the day's competition. It is noteworthy that even at 23,600ft MSL the Eagle can pull almost 5*g* to track the "'Fishbed' simulator." The hard turning fight has slowed down to 305 knots with the F-5 even slower (note 105 knots of overtake). The "XXX" in the lower left means the M61A1 gun is SAFE and the bright light in the upper right (called a "witness mark") means that the trigger is fully depressed. (Author's Collection)

As the Harrier Driver saw the Eagle swooping down, he would carefully time his VIFFing maneuver to rotate the GR.Mk 3 broadside in front of the F-15. The sudden loss of thrust from rotating the nozzles downward also acted as a powerful speedbrake and the Harrier seemed to stop in space. If – and this is a big if – the Eagle Driver was not paying attention, hadn't done his homework, or "had his fangs out" going for the kill, an embarrassing overshoot could result. As the Eagle zoomed by, the Harrier would tuck the nozzles in, put the "iron sight" on the glowing F100 afterburners and shoot a Lima up his tailpipes.

Far more often the sudden rotation of the Harrier in front of us and the appearing to come to a complete stop in the air was warning enough that there was some VIFFing going on. In this case, the Eagle Driver simply went to idle and pulled on the pole to exchange knots for altitude and zoom up and out of the Harrier's WEZ. Rolling over on our backs, we'd chuckle to ourselves as we began to compute the trajectory needed to return to guns parameters. He was now out of knots and "dead in the water."

This is because airflow over the wings is what generates lift at 10,000 feet, and after VIFFing the Harrier had none. The vectored thrust at that altitude (since thrust coming out the exhaust is proportional to the air being gulped in the front; no knots: no air) was only a fraction of the weight of the aircraft and consequently the Harrier would have to roll off to one side, put its nose down and begin accelerating again as it descended to the floor of the DACT airspace. Tipping its tail up to dive, it frequently offered an attractive heat source to the AIM-9L's seeker head since now the wings no longer provided a cover over the exhausts – "Fox Two kill the Harrier diving through 7,000 feet."

Because of supposed similarities with the Soviet Navy's Yak-36 "Forger" carrier-borne fighter, fighting the Harrier was more than just "fun over the Mediterranean."

MIKOYAN-GUREVICH MIG-23 "FLOGGER"

It has recently been revealed and declassified that the USAF was operating a squadron of MiG fighters from Tonopah airfield, Nevada, in a unit known as the 4477th Test and Evaluation Squadron "Red Eagles," in a program codenamed *Constant Peg*. The 4477th TES was made up of aggressor pilots, weapons school instructors and USN "Top Gun" school graduates who flew 12 to 16 MiG-21 "Fishbeds" and four to eight MiG-23 "Floggers" against the F-15 FWIC, *Red Flag* forces and F-15 units visiting Nellis AFB to participate in *Red Flag* exercises. Consequently, almost all F-15 pilots from the 1978–88 timeframe were provided an opportunity to fly against the Soviets' most capable fighters of that time.

The MiG-23 was highly touted by Intel for its high acceleration and maximum speeds, and was credited with a medium-range "depressed angle" ("High Lark") pulse radar and SAR (AA-7 "Apex") missile. The aircraft was most similar to a single-seat F-4 with VG wings. The radar was similar, the AA-7 was almost identical to the AIM-7E, and some features were uncanny twins of parts of the Phantom. However, tasked, among other things, to "run down" swing-wing F-111 bombers, it had only a minimum dogfighting capability.

To practice against it, we would brief with the "Red Eagle" pilots in a trailer on a seemingly vacant lot off in one corner of the Nellis air base and they would fly up to Tonapah to hop in their jets. Meanwhile, we would brief, step to our jets and start engines, taking off to head out to their work area in the northeast corner of the Nellis ranges.

When we reported in, they would fire up their Tumansky R-29B turbojets, taxi out and take off. Their fuel was so limited, this was the only way they could provide enough training time. Once the fight was on, we would lock them up and accelerate to try and get a missile into the air first. Usually the "Floggers" would split to execute a "pincer" type attack[22] or one MiG would "beam" or "drag" while the other pressed in towards the merge attempting to light us up with his "High Lark," hoping to force one of us defensive at the outset. At the right time (determined by their GCI controller), the second "Flogger" would point back into the fight hoping to get close enough to use the "Apex."[23]

For us, the normal tactic would be to shoot and crank (angling off to one side approximately 45 degrees) while the first "Flogger" came down the "snot locker" to meet the Sparrow halfway. If the MiG was persistent we would dive sideways "into the notch" and descend below the "Flogger's" altitude, which would invariably cause a break-lock. (The AIM-7F out-ranged the AA-7 but the latter still had to be taken seriously.) Then it would be a matter of pitching back towards the incoming target, using Auto-Guns to get an early lock and a Lima in the air.

Meeting the MiG at the merge, the wings (like those of a Tomcat) indicated the pilot's intentions. If they were all the way back, he was planning on "blowing through"; if they were out, he'd be wanting to try and maneuver with you. If we saw the wings full back, we would start a "no respect" lead turn at maximum *g*, willing to give up all the knots to be pointing at him when he went by and stuff a Lima up his tailpipe and follow that with a "fade away jump shot" AIM-7 to be sure of the kill.

If his wings were out you had to give him a little more respect, delaying the lead turn to ensure you wound up behind his "wing line" and maintained sight of him always. Then you'd be on the inside of his turning circle with him going defensive in a hard turn immediately. A quick Vertical Scan radar lock, thumb to SRM, uncage the Lima's seeker head, get a good tone and shoot, and you could get an AIM-9L airborne during BFM before the min-range "Break X" (a symbol in the HUD for minimum missile range) negated the shot. Then it would just be a matter of taxiing into gun range, putting the pipper on the Gomer's (bad guy's) head and letting a few seconds of Vulcan fire take his MiG apart.

Constant Peg did wonders for our understanding of the Soviet fighter technology, its capabilities and its limitations. It made us so much better at our "game" that when Eagle Drivers actually had to fight guys flying these things they were absolutely dominating – 92 kills to no losses. It showed us that the F-15 we were flying was indeed truly "awesome!"

CR
019
CR
015
CR
AF 79 027
CR
AF 79 028

06

ACTIVE DUTY EAGLE UNITS IN THE COLD WAR

READY EAGLE PROGRAM

While the USAF was suffering mounting attrition in SEA, from 1965 to 1972 the Soviets were strengthening their forces in Eastern Europe and making alarming advances in fighter technologies. With "Foxbats" and "Floggers" being fielded in large quantities at bases in East Germany (the German Democratic Republic or GDR; DDR in German), Czechoslovakia, and Poland, the USAF was anxious to counter with the new F-15 Eagle as quickly as possible. By 1975 USAF intelligence staff estimated that the Soviets and their Warsaw Pact allies outnumbered NATO air forces 2:1 in Western Europe. If there was going to be another shooting fight in the otherwise Cold War between the Communist East and Western democracies, it would be in Western Europe, a battleground absolutely critical to the US and its survival and prosperity. It was imperative to upgrade USAFE's air defense forces as rapidly as possible.

Therefore, while the 1st TFW had generated two combat-capable F-15 squadrons at Langley AFB in 1976, the next year it was to deploy to West Germany (the Federal Republic of Germany) three battle-ready Eagle squadrons and bring its third squadron up to operational status. McDonnell Douglas was now delivering F-15s at the rate of nine per month and the vast majority of these were going to Langley to fill out the new Eagle squadrons of the 36th TFW, based at Bitburg Air Base (AB), West Germany.

The 36th Fighter Group had been a 9th Air Force P-47 Thunderbolt fighter-bomber unit during WWII, slugging it out against Nazi flak units as it covered Patton's Third Army driving across France to topple the Third Reich. Consequently it did not have a strong heritage as an air-to-air unit, having destroyed only 42 German aircraft in the air, but in 6,947 combat sorties in less than a year of combat its pilots had destroyed 262 armored vehicles – many of them during the famous Battle of the Bulge – and 420 locomotives. Following the war the unit re-equipped with the Lockheed P-80 Shooting Star, the USAF's first jet fighter and in 1948 it became the first jet unit in USAFE when 16 F-80Bs arrived at Fürstenfeldbruck AB near Munich in August 1948 after flying (via several refueling stops) all the way "across the pond." The unit returned to its roots as a fighter-bomber wing in 1950 and transitioned through the Republic F-84E[1] (under Col Robert Scott, WWII fighter pilot, commander and author of *God Is My Co-pilot*), North American F-86F Sabre (as a Fighter Day Wing), North American F-100C Super Sabre (as a TFW), Republic F-105D Thunderchief, and McDonnell Douglas F-4D Phantom II. It moved to Bitburg, a base built by the French (under an American contract), in the Eifel region, near the Luxembourg border, in 1952.

OPPOSITE
This four-ship of "Wolfhounds" is loaded for "Bear." The 32nd TFS's initial batch of F-15As was replaced by the much improved – but visually indistinguishable – F-15C, seen here early in the 1980s (note the white missiles). After 10 years guarding NATO's skies, three of these jets were sent to the Royal Saudi Air Force in September 1990 after Saddam Hussein occupied Kuwait. Aircraft 79-0027 was transferred two years later to the 325th TTW at Tyndall AFB, Florida, where it was lost in an accident on March 15, 1993. The pilot ejected safely. (USAF)

By this time the 36th TFW (tailcode "BT") was composed of three squadrons: 22nd TFS "Stingers," 53rd TFS "Tigers" and 525th TFS "Bulldogs." The last mentioned was the wing's primary air-to-air squadron, having arrived at Bitburg as an interceptor unit with Convair F-102A Delta Daggers in 1959. It provided air defense with the "Deuce" while the rest of the wing flew "Thuds" in the nuclear strike and air-to-ground roles, and when the wing re-equipped with Phantoms it was the unit with the primary air-to-air DOC. Thus it was natural that the "Bulldogs" would be the first of the 36th's squadrons to transition to the USAF's newest air superiority fighter.[2]

In December 1976 the 525th TFS stood down at Bitburg and went to Langley to convert to the Eagle. As with all the 36th's squadrons, half of the F-4 pilots were selected to convert to the F-15, the rest of the reconstituted unit being made up of now-experienced Eagle Drivers from the 27th and 71st TFSs and Eagle instructors from Luke. The 94th also trained Bitburg's new Eagle keepers, beginning in late September 1976, and by mid-April the next year the required 522 qualified technicians were trained and in place at "The Bush."[3] Additionally, on January 7, 1977 two F-15Bs (75-0049 and -0050) were ferried non-stop in a 7.5 hour flight directly from Langley AFB to become maintenance trainers in anticipation of the arrival of the whole squadron.

Meanwhile the 36th Wing Commander, Brigadier General Fred Kyler, the "Bulldog's" boss and 30 other pilots were brought up to mission ready (MR) or mission capable (MC) in the case of wing staff pilots,[4] the first passing his MR check ride on January 14,

BELOW
525th TFS F-15Cs stand ready to launch outside the Roether Memorial Zulu Alert Facility at Bitburg AB, West Germany. Note the HGU-55 helmets ready to be donned quickly as soon as the jet fuel starter handle was pulled and the Eagle growled into life. F-15 80-019 was a "Bulldog" jet for most of its career in USAFE. It is now on strength with the 57th FW at Nellis AFB, Nevada. (USAF)

ROETHER MEMORIAL
ZULU
ALERT FACILITY
636
BT
AF 80 019
BT

1977. However, training individuals was only the first part of building a combat ready unit and in the three months that followed, 25 "Bulldogs" participated in a *Red Flag* exercise before readying for their deployment to Germany.

While the pilots were ready, the jets were not. The P&W F100 turbofan had begun to plague the Eagle, as it would do throughout the engine's service life. Langley experienced a rash of catastrophic failures of F100 fuel pumps and by March HQ TAC declared them unsatisfactory for a seven-hour-plus over-water deployment flight. Additionally, delivery of aircraft from the depot installing the ECM equipment (supplied by the AF, not McAir or one of its subcontractors) was slow. However, with the arrival of redesigned fuel pumps and sufficient jets, the complex night launch and tanker rendezvous for the deployment to Germany was finally practiced on the night of April 20/21.

Following the successful dry run, at 03:53 EST on April 27, BrigGen Kyler led the first cell of three F-15s (one ground abort) and two air spares into the air and they headed north to join up with the first of a total of nine KC-135s used to make the flight possible. The three remaining cells launched from Langley following at 30 minute intervals. In a deployment reminiscent of

BELOW
Two 53rd TFS "Tigers" F-15Cs taxi out for take-off at Bodø, Norway. The "Tigers" deployed to Bodø for a one-off TDY (temporary duty assignment) to fly cover for a NATO Naval Task Force operating off the Norwegian coast, intercepting Soviet Naval Aviation Tu-95 "Bear-Ds" and "Es" shadowing the NATO warships. The Squadron served TDY because the aircraft carrier that would normally have provided air cover was engaged with Libyan forces in the Gulf of Sidra. Aircraft 79-073 was delivered to Bitburg on May 5, 1982 and spent 11 years there before being transferred to the 1st FS, 325th FW at Tyndall AFB, Florida, as a training jet. (USAF)

BT
BT
AF 79 073

the 36th's first jet flight to Europe in 1948, the wing's first 23 F-15s were all on the ground[5] at Bitburg by 17:30 hours CET (central European time) that afternoon and four of them were being "cocked" for air defense alert.

"ZULU WARRIORS"

The 36th TFW had three missions to fly for NATO. In peacetime it was Air Policing of NATO – specifically FRG – airspace. In wartime it was Air Defense on our side of the front, and going "across the fence" it was Air Superiority on the other side.

The three squadrons[6] of the 36th TFW fit easily into NATO's Central Region integrated air defense system (IADS). When the Eagles joined USAFE, NATO had recently reorganized its Central Region[7] to meet the increasingly capable threat from the East. Allied Air Forces Central Europe (AAFCE) was headquartered, along with HQ USAFE, at Ramstein AB and its command was divided between the British-run 2ATAF (Allied Tactical Air Force) – which protected northern West Germany and the Benelux nations and included units from five nations – and the American-led 4ATAF, which defended southern FRG together with units from the *Luftwaffe*, Canadian Armed Forces and USAF. The air defense forces "chopped" (CHange of OPerational Control) to AAFCE by all the nations included SAM batteries and GCI radar sites (called control and reporting posts, or CRPs, in NATO parlance) as well as flying units. Operationally they were controlled by NATO control and reporting centers (CRCs) which would meld the data from CRPs and E-3 AWACS (Airborne Warning And Control Systems) platforms to build an "air picture" and attempt to manage the air battle by feeding in fighters or calling them off and unleashing SAMs in the area under attack. The CRCs were, in turn, under the Sector Operations Centers (SOCs),[8] which coordinated offensive and defensive operations and, in peacetime, retained centralized control over air defense units and the exercise of Air Policing actions.

Through the 1960s and most of the 1970s USAFE's basing scheme for its air defense fighters was to spread the dedicated AD units at various bases in the region. This was because the range, radar and weapons limitations of Sabres, Super Sabres and Delta Daggers generally restricted them to a point defense of vital targets rather than a comprehensive defense of the whole region. Even when the more capable F-4E arrived in-theater, the basing arrangements remained unchanged, with one Phantom squadron in each wing providing air defense for its base area and air-to-air escort for its wing's other squadrons. But the quantum increase in capability brought to NATO's Central Region by the F-15 changed all that.

With the ability to range all across the FRG imparted by the F-15's economical F100 turbofans, it was now possible to concentrate USAFE's air defense fighters at just a couple of main bases. Backed up by two squadrons of F-4Es (the 86th TFW's 512th and 526th TFSs) stationed at Ramstein AB, the three squadrons of Eagles at Bitburg provided the primary air defense force for the whole of 4ATAF. For peacetime Air Policing operations – the interception, interrogation and intervention of any unknown aircraft entering 4ATAF's airspace – each of these two bases kept two two-ships armed and ready to go on what was called Quick Reaction Alert (Interceptor) or QRA(I), but better known as "Zulu Alert" after the title of that portion in NATO's extensive catalog of war plans.

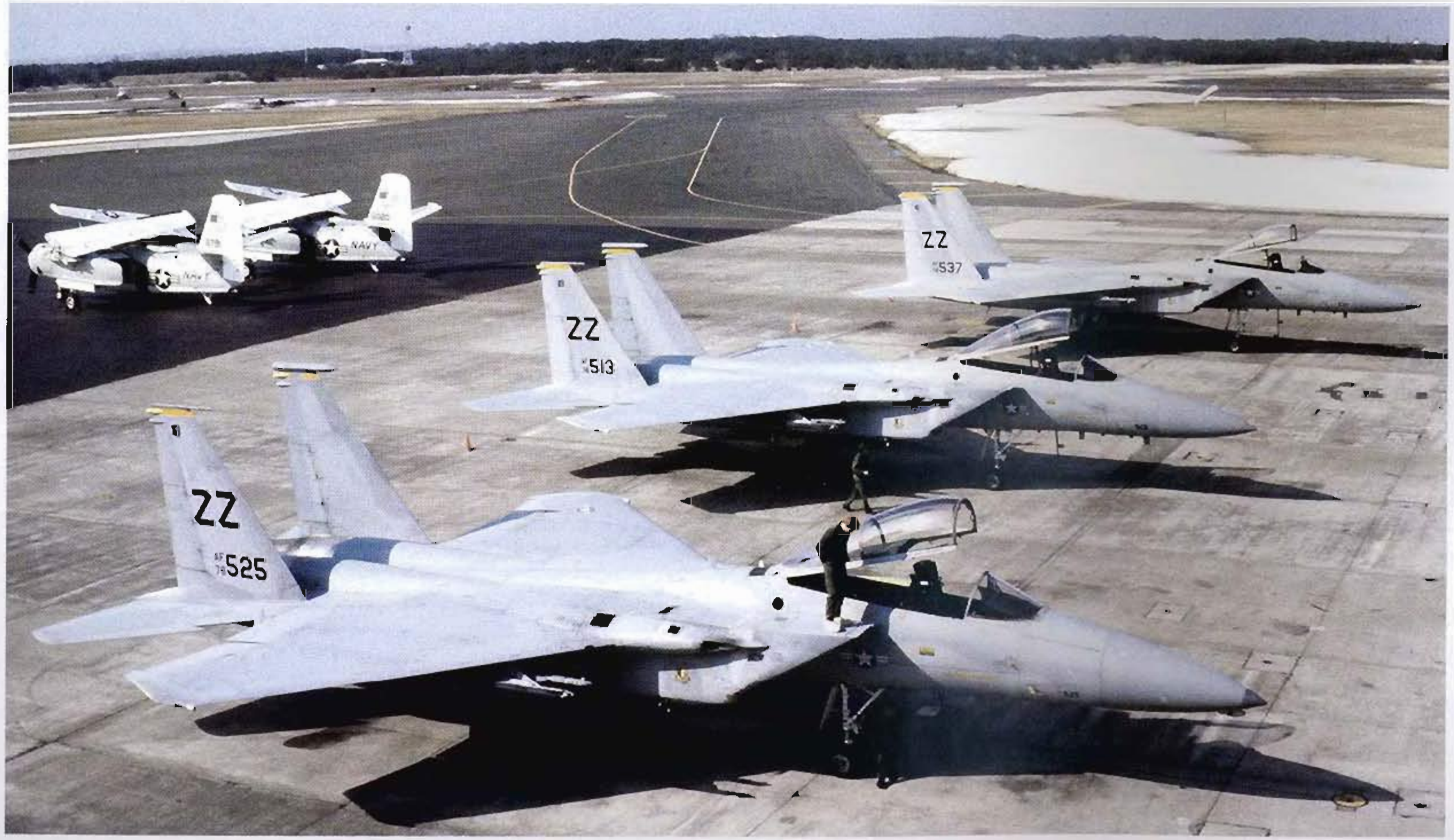
At Bitburg the four alert birds were housed in the Zulu barn, a large alert facility formerly used by the 36th TFW's nuclear-armed Phantoms sitting "Victor Alert." The barn was located at the north end of the air base, just off the approach end of Runway 24, and consisted of a two-story "alert shack" flanked on each side by a huge bay, each housing a pair of Eagles sitting side-by-side, cocked and ready. These four F-15s were on 5-minute QRA(I) status with two spares loaded but not cocked in individual Tab Vee hardened hangarettes nearby. Normally each pair of jets was provided by a different squadron, so all three units on base were equally tasked and represented on alert. They were worked by an independent (answering directly to the 36th TFW Director of Maintenance) and dedicated Zulu Alert crew.

Two pairs of pilots – each element from a different squadron – cocked the jets each morning and lived in the "alert shack" for 24 hours, taking to the air at the blaring sound of the klaxon. Normally a squadron was tasked to provide the primary element (including "Zulu Commander") for a month, the secondary element the next month and was off alert duty the third month before returning at the start of the next cycle.

There were two types of scrambles: Alpha scrambles were actual launches to intercept and investigate any unknown radar track, such as a lost aircraft, known as a "zombie." Tango scrambles were practice, or training scrambles used to exercise the entire IADS network and provide training for the launch crews and pilots. Normally Tango scrambles were launched two to three times a week, mostly during daylight hours.

Tango scrambles would often be launched to a designated Low Fly Area, of which there were eight spread across relatively sparsely populated terrain in the FRG. Simulating ordnance deliveries (firing missiles) was forbidden in an armed fighter, so low altitude intercepts would be flown – either against each other, or as a two-ship against "strangers" in the area – to visual identification parameters. The master arm switch could not be moved to ARM without authenticated authorization from GCI (on an Alpha) and even "calling shots" on the radio was prohibited.

For a variety of factors the "Zulu Warriors" might be sent into the high altitude structure (above Flight Level 360 supersonic flight was sometimes authorized by GCI) for Practise Intercepts, or PIs. PIs were also known as "Pigs In Space" after the skits involving the misadventures of the porcine-shaped spaceship on the children's



BELOW
F-15As from Kadena's 18th TFW sit on the ramp behind a pair US Navy Grumman C-1 Traders in the late 1970s. Japan was host to a single wing of Eagles and would later itself become an Eagle operator. (USAF)

"LIMA ALPHA ZERO ONE, Tango Scramble Two!" – Sitting Hot Alert in the Cold War *by* Doug Dildy

For 15 years (1977–92) sitting 24-hour air defense – codenamed Zulu – alert was a fact of life for an Eagle Driver at Bitburg. When scheduled for Zulu the pair of pilots would show up at their squadron, frequently before any other members, and using the 36th TFW Zulu Briefing Guide discuss how they would conduct the launch, intercept and recovery. Gathering their flight gear from Squadron Life Support Section, they would drive over to the Zulu barn and check in with the element they were replacing. There would be a quick brief by the outgoing Zulu Commander on the status of the jets and any intelligence regarding Warsaw Pact air activity. The oncoming pilots would then order breakfast (provided by the 36th TFW support group) and walk out to their jets, inspect, start and cock them.

Cocking the jet consisted of starting the aircraft, testing all the functions that would be needed on a QRA(I) scramble and intercept, and setting the switches so that the systems would come to life in the mode needed. These included firing up the radar and doing all of the BIT checks, tuning the AIM-7s to the radar's frequency and checking that the AIM-9Ls each slaved to the radar and had a good tone. The INS was given a complete GC (for gyrocompass) alignment, usually about a nine-minute process, and the data in its memory was checked for accuracy. Once the amber "ALN" (alignment complete) light was flashing, the control knob was rotated to OFF to save, or "store," the alignment. All aircraft checklist items were accomplished through *Before Taxiing Checks* – including lowering the flaps to take-off setting – to be sure the jet was ready to launch. The radios were set on the frequencies for Bitburg tower in the "main" (No. 1 radio) and Bitburg command post (CP or BARON) in the "aux" (No. 2 radio). After engine shutdown, the INS knob was rotated to "STOR" so that when the engines started and the generators kicked in the system would immediately access the saved or stored alignment (a three-minute process and usually the limiting factor in a timely launch).

Once the jets were cocked and the pilots and ground crew were back in the "shack," breakfast would be served and everyone would sit down for a relaxed meal. With everyone together the Zulu Commander would announce he was doing a "horn and lights check" (to keep from interrupting breakfast with a dash to the jets), and call the CP to get a test on the klaxon and lights. To back up any contingency of lost comms with the CP, a set of three lights was mounted to the wall of the Zulu hangar bay: green for "Go," yellow for "start engines and await instructions" (known as "Slingshot" status) and red for "Don't Go" (which of course would have to be authenticated). With all checks done, the Zulu Commander would report four jets "on status" and the Zulu crew would settle into the dullness of another 24 hours in the barn.

The barn's living accommodations consisted of a kitchen, small dining area, and relaxation/ready room containing sofas, books, magazines and television on the ground floor. Upstairs was the sleeping area with the four pilots' beds in line abreast near the brass fireman's pole and the "battle cab" at the forward end of the upper floor. The "battle cab" was wired into 4ATAF's AD and Bitburg's CP communications network and frequently, if something was up, the Zulu Commander would "hang out" there monitoring the discussions on the net and get (or give to his crew) a head's up that a launch might be imminent. (If the words "Three Six, COPPER RING..." were ever heard coming in over the net, we knew a scramble was imminent and immediately began stumbling over each other to get to our jets.)

Regardless of any notification, when the klaxon blared the pilots and Zulu ground crew would scramble. If it occurred during sleep, the pilots would literally jump out of bed and into their flight suits and boots (left properly positioned for the jump when retiring), tighten their boots, zip up their suits and head for the pole. Adrenalin would be pumping but we had to pause long enough to allow the preceding pilot to clear the bottom of the pole (lest a collision at the base of the pole knock out 50 percent of the alert force). On the ground we would dash out to our respective jets. Our *g*-suits would be hanging from the ladder and zipping them on – while the ground crews opened the hangar doors, pulled on their headsets and moved into position for engine start – we'd clamber up the ladder and drop into the seat, pulling the JFS start handle as we did so. As the JFS wound up to ear splitting scream one of the maintainers would buckle us into our harness and exit, remove the ladder and move to be ready to pull the chocks.

As this blur of motion was progressing, as soon as the rising sound of the JFS cranking leveled off, we would raise the finger lift (on the front of the throttles) to start the first engine. As soon as the first generator was online we'd turn the radar on and the INS would start "cooking" in its alert alignment and the radios would click on. Raising the finger lift to start the second motor, now only two to three minutes into this well-practiced drill, the four ship flight lead would pull out his pencil and, getting a nod from his wingman alongside him, would press the mike button to the rear to check in and contact Bitburg CP.

"LIMA ALPHA ZERO ONE, check."

"Twoop."

"Three."

"Fourp."

"BARON, LIMA ALPHA ZERO ONE with four, ready to copy words."

"LIMA ALPHA ZERO ONE, Tango Scramble Two' to Low Fly Seven. Contact STRAWBASKET GCI center on TAD 631 [tactical air defense frequency 631], back-up 635. Time now 03:00Zulu, Authentication Sierra Hotel."

"LIMA ALPHA ZERO ONE copies."

"Twoop."

"Three."

"Fourp."

Checking to be sure the engines were running in limits at idle, the radar had timed in, the ALN light was flashing, and his wingman was ready (helmet nod), the flight lead would give the pull-chocks signal. Getting a thumb's up from the crewchief that they were clear, and a salute, he would push the throttles forward and press the mic button forward as well. After a quick check in, he would call, "Bitburg tower, LIMA ALPHA ZERO ONE, Tango Scramble Two."

"LIMA ALPHA ZERO ONE, cleared for take-off, runway 24."

Swinging onto the runway, we'd push the throttles into afterburner, wait for the first punch in the ass signaling a light off, then shove them all the way forward into "full blower." The sidelines would become a streaking blur and the airspeed needle started winding rapidly around the dial. A quick pulse on the stick to get the nose up, airborne, get the gear up, flaps up, accelerating the jet to match our rushing heartbeats. At the end of the runway, we'd give a strong pull on the "pole," condensation streamers wafting from the wingtips as the jet rotated skyward, blasting like a space rocket into the air. Behind lead, the wingman would complete the same process, tipping his jet back on its tail to put LA01 into the large green SuperSearch circle on the HUD, get a lock and call "Tied."

Approaching 7,000 feet, at the top of the near vertical climb, the leader would roll off to the east and send his wingman to the TAD frequency. As he saw the wingman roll out of his climb in tactical formation alongside him, the leader would check in, "STRAWBASKET, LIMA ALPHA ZERO ONE, check."

"Twoop."

A distinctly German accent would then respond, "LIMA ALPHA ZERO ONE, vector one-one-zero, climb angels two-five [25,000ft]."

With that call we were headed for the low altitude training area called "Low Fly Seven," probably to meet Neuburg's (*Luftwaffe*) F-4F Phantoms over "Hasselback Ridge" for 2 v 2 low altitude intercepts. By the time we'd get there, our heart rates would back off to inflight normal and our brains would catch up with the jet and begin doing what we'd been drilled to do, working the radar, comms, and weapons parameters (master arm switch stayed in "SAFE") to intercept any potential "bad guy." We did so knowing that with their own radars, the real "bad guys" were sitting on the other side of the fence watching and listening to us. We did all this to convince them that they would be met with the same fast and lethal response should they put so much as a toe over the line.

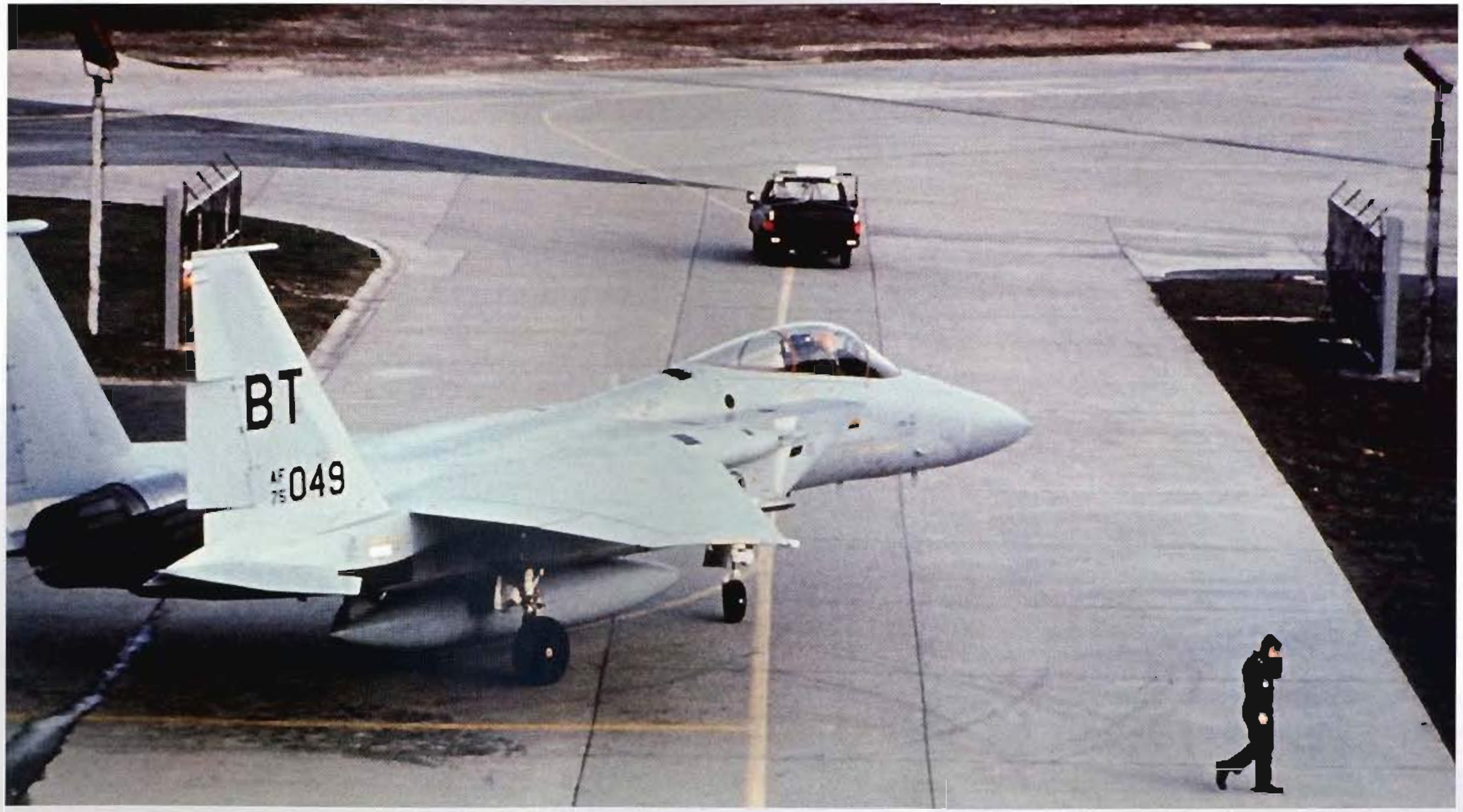
Muppets TV show. Even with both F100s cooking in A/B, maneuvering a fully loaded F-15 – eight missiles and a centerline fuel tank – in the very thin atmosphere near the tropopause (also known as the "Bozosphere" after a certain circus clown), made the magnificent Eagle feel as if it had all the aerodynamic qualities of "Miss Piggy."

Cute nicknames aside, QRA(I) was an intensely serious business because Eagle Drivers were piloting fully armed jets over the length and breadth of a nation at peace. Airborne errors could result in damage to property and injury to, or the death of individuals. Consequently any miscue was taken very seriously, at least until the "dust had settled" and the debriefing was over. Then maybe we could laugh about it.

For instance, one time two 53rd TFS pilots – with the unlikely, but telling, combination of callsigns of "Hammer" and "Nail" – were Tango scrambled to the "Black Forest High" area for PIs. With only themselves "to play with," "Hammer" split the flight and in accordance with the usual practice began to alternate "target" and "fighter" so each would get about the same number of PIs. On what would be the last PI, "Hammer" headed in as the target and "Nail" quickly got a lock, called "Judy" (a radar contact on the correct target) and offset to one side to run his wide, high altitude conversion to the stern. Seeing "Nail" correctly lock him up (on RWR) and monitoring him on radar to be sure he stayed in the work area high above the Schwarzwald, "Hammer" looked down at the INS to begin programming it for the recovery into Bitburg.

At that moment, he was surprised by a sudden "Whoosh!" and jerking his head up, he saw a missile flying straight out in front of him. His instinctive reaction was to check six because his first thought was that someone was "hot nosing" him (shooting missiles at him from astern). No one there. Looking down at his armament control panel, he saw that one AIM-9 had abruptly and

BELOW
A "Bulldog" jet (F-15A 75-049) emerges from its secure parking area. Noteworthy are the black wheel hubs (a common feature on early A-models) and the pilot's customized red HGU-36 "bonedome." After serving with the 525th TFS, 75-049 was used by the 461st TFTS (1981–87), 95th TFTS (1988–92), 128th FS of the Georgia ANG and finally by the 159th FS, Florida ANG. (USAF)



autonomously left its rail. Shocked, he ensured that the master arm switch was still in SAFE and then went to work recording the data. He captured the aircraft's position in the INS (in latitude and longitude), altitude, and heading, and even thought to check the INS for the winds aloft at that position and altitude. As "Nail" completed the intercept "Hammer" explained what had just happened and had "Nail" conduct a battle damage assessment (BDA). "Nail" reported that indeed, one of his AIM-9s was missing.

LA01 and 02 immediately RTB'd (returned to base) and "Hammer" had a host of people waiting to talk to him. As is (sadly) typically, the case in events such as this the pilot was immediately blamed for the event. "Guilty until proven innocent," "Hammer" was intensely debriefed by safety, security, and commanders, and was grounded until the outcome of the investigations. His video tape recorder (VTR), which was supposed to be set to "STBY" (standby: the VTR was energized and tape threaded, ready for recording), "TRIG" (for trigger, meaning the VTR would come on when a fire signal was sent to the weapons system by pressing the weapons release switch or pulling the trigger) and HUD (when the camera did come on it would be recording the scene through the HUD) showed nothing. Naturally those who blamed pilots assumed he had turned the VTR off and got trigger happy to see what an AIM-9 launch would look like. However, what it really meant was that there was never a fire signal sent from the control stick to launch the missile, it just shot off the rail on its own.

Sure enough, a complete tear-down of the aircraft's fire control system showed a fault in one of the components of the AIM-9 firing system, the small box mounted in the underwing pylon that sent the electrical impulse that ignites the missile's rocket motor. A static electrical charge had built up in the box and when it had sufficient energy to overcome its internal resistance it fired the ignition circuitry and the missile shot off the rail just as it was designed.

Formerly the whipping boy for this incident, "Hammer" soon became the hero for having noted all the data at the moment of missile launch. The smart guys in the weapons shop plotted LA01's location and altitude, the ballistics of the missile fired straight and level and then, after rocket motor burnout, arcing over into a dive and even applied the winds. The result was a narrow fan-shaped area spread across a small part of the Black Forest – most probably the point of impact lay within that area. Armed with that information, USAFE mobilized battalions of searchers to scour the heavily forested area looking for the remains of a spent AIM-9.

Meanwhile, in a barn in the Schwarzwald, a German farmer walked in to milk his cows and noticed a hole in the roof. He didn't think much of it at the time, but with all the hoopla associated with the inadvertent missile firing, when questioned by the searchers, he dutifully reported the hole in his barn's roof. Inside, directly beneath the hole, the searchers found nothing, just a pile of manure covered with straw. Upon further, deeper investigation – by lifting the straw off the manure and pushing the poop aside – a matching hole was discovered in the concrete foundation to the barn. Deep in the hole, and having broken up into three components – rocket motor, guidance unit and warhead – was the shattered remains of the only AIM-9 to be fired by an F-15 on a Zulu scramble.

In retrospect, once the missile pieces were recovered and everyone had a chance to breathe easier and maybe even laugh about it a little, the entire episode was a telling and reassuring experience. It showed that yes, indeed, the new AIM-9L could, in fact, "hit the broad side of a barn," and that the US Air Force could actually find a needle in a haystack.

Not all events during a Zulu launch proved to be funny, no matter how much time has passed. In fact we lost several good men on Tango scrambles. Capt Jeff "Wedge" Roether, one of the Tigers to whom this book is dedicated, lost his life when doing PIs over the Eifel. His F-15 had previously experienced a chronic series of cabin pressurization failures that were never fully corrected, and on the occasion of his last Zulu Scramble his jet's oxygen system failed him also, allowing him to breathe the thin, oxygen-starved air of higher altitudes. It was not enough to sustain consciousness and he was killed in the ensuing crash.

Flying off Zulu was indeed a very serious business. It was something that the Eagle Drivers of the 36th TFW at Bitburg and the 32nd TFS at Soesterberg did as a fundamental part of their jobs, a mission repeated by the 18th TFW's alert detachment in South Korea and later by Alaskan, Stateside air defense and Air National Guard (ANG) units. Having a real world mission set these units apart from those that merely occasionally practiced these procedures as part of their training or some exercise deployment.

READY EVERYBODY ELSE

By the end of FY1977 some 245 F-15s had been delivered and TAC had met its objective of providing two fully equipped combat ready wings – 76 jets were at Langley with the "First Wing" and 73 were on the frontlines of the Cold War at Bitburg (six more were received by December for the wing's full complement). Fifty more were at Luke with the 58th TTW's[10] training squadrons and the 57th FWW had another 14 at Nellis. As shiny new Eagles continued to roll off the production line at a rate of nine per month, the third USAF Eagle wing began its conversion to the F-15. It was the "dual based" 49th TFW (tailcode "HO") stationed Stateside at Holloman AFB, Alamogordo, New Mexico.

The 49th TFW was a historic air-to-air fighter unit having dominated its Japanese adversaries after tenuous beginnings in the South Pacific. It was activated at Selfridge Field, Michigan, in January 1941, and trained on the Curtiss P-40 Warhawk, in the dark days following Pearl Harbor. The 49th Pursuit Group was the first complete fighter outfit to deploy into combat, arriving in Australia in February the next year to face the aggressive, combat experienced Japanese army and naval air forces. Fighting its way across the Pacific, the 49th Fighter Group ended the war with 667 aerial victories, having spawned 36 aces, the most notable of which was America's ace-of-aces, Maj Richard I. Bong, who was a member of the unit during the first of his three tours of duty and scored 21 of his 40 victories with the 49th.

In the Korean War the group found itself as a ground attack unit using F-80s and F-84s. With the advent of NATO in 1949 and the Cold War build-up, the unit was moved all the way around the world to Europe and upgraded to the F-100C Super Sabre in the nuclear strike role, being stationed at Etain, France, until De Gaulle pulled his nation out of active participation in NATO. Then it moved to Spangdahlem AB – across the Kyle River valley from Bitburg – in 1959. From Spangdahlem it flew the F-105D until being withdrawn eight years later to provide 7th Air Force with more Thunderchiefs, backfilling SEA units being rapidly depleted in the air war over NVN.

The 49th TFW moved to Holloman AFB, New Mexico, where it re-equipped with the multi-role F-4D Phantom II and trained for quick reaction "cross the pond" deployments back to Spangdahlem (which now was used by an expanded 36th TFW to house its 23rd TFS, 39th TEWS (with EB-66s) and other assets) under the *Crested Cap* concept. In concert with the US Army's annual *Reforger* event (REturn of FOrces to GERmany) the 49th would return to Ramstein or Hahn each year for several weeks of intensive exercises.

Consisting throughout its history of the 7th TFS "Bunyaps,"[11] 8th TFS "Black Sheep," and 9th TFS "Iron Knights," the 49th TFW upgraded to the Eagle through the *Ready Holloman* program (formally called *Ready Eagle II*) conducted at the relatively close by Luke AFB, Arizona. The 461st TFTS assisted the squadrons[12] of the 49th in becoming mission ready much as the 94th TFS prepared the squadrons of the 36th TFW for their wartime mission.

The "Holloman Eagles" would lead a rather undistinguished career with the F-15, partially due to the dual-basing nature of their existence. The Wing completed conversion to late production F-15As by December 1977, the last active duty USAF unit to operate this early model. The 49th made history when two of its Eagles flew 6,200 miles in just over 14 hours, establishing a record for the longest flight of a single-seat fighter aircraft.

Always the bridesmaid, never the bride, it continued to participate in annual trips to Europe, trading its *Crested Cap* role for *Crested Eagle* deployments to Ålborg, Denmark, to reinforce the air defense of NATO's BALTAP (Baltic Approaches) region. Its only wartime deployment was to Tabuk, Saudi Arabia, to relieve the 33rd TFS "Gorillas" (58th TFS) following their victorious air superiority campaign in Operation *Desert Storm*. Afterwards the 7th TFS "Bunyaps" was deactivated on September 30, 1991, its final F-15A sortie being flown by the 49th TFW commander, Col Frank "Ted" Campbell, with the Wing's other two squadrons following the next year. The last F-15 departed Holloman on June 5, 1992, ending 14 years of Eagle operations.

While the 49th TFW "flag" was transferred to the unit of Lockheed F-117A "Stealth Fighters" which, following their very successful employment in *Desert Storm*, moved from their secret base at Tonopah, Nevada, to be stationed at Holloman, the by now quite dated F-15As were still needed in the USAF inventory. Although external appearance changed little, they were being highly modified internally with the extensive Multi-Stage Improvement

Program (MSIP) and were being delivered to the 32nd Fighter Squadron at Soesterberg and various Air National Guard units.

Initially it was planned for USAFE to have two full wings of F-15s, but the 86th TFW remained equipped with the F-4E and only one squadron, the 32nd TFS "Wolfhounds," upgraded to the Eagle. The "Wolfhounds" had a unique role in the history of the USAF. It began its history as a WWII P-36 and P-40 fighter unit (curiously as part of the 36th FG until its parent unit departed for France) guarding the Caribbean, from bases on the Dutch West Indies islands of Aruba and Curacao. This Dutch connection resulted in the USAF deciding to use this designation for its sole fighter unit stationed in the Netherlands. Arriving at Soesterberg (also called Camp New Amsterdam after Holland's American colony that eventually became New York City), a Koninklijke Luchtmacht (Royal Netherlands Air Force, KLu) base near Utrecht, as a day fighter squadron[13] with F-86Fs, in late 1954, the unit was renumbered as the 32nd the next September and transitioned to F-100Cs the year after. In 1959 the unit was re-roled as a Fighter Interceptor Squadron and was attached to USAFE's air defense HQ, the 86th Air Division. It re-equipped with the F-102A the next year and transitioned to the F-4E in 1969.

A tenant unit on a Dutch base operating in British-controlled 2ATAF, this squadron had a unique NATO experience, semi-autonomous from its American command (the 17th Air Force) and infused with a more cosmopolitan perspective of its role. This was reflected in its unit patch which took the WWII Disney image of the "Big Bad Wolf" (from the *Three Little Pigs* cartoon) and, with the approval of its hosts, surrounded it with the KLu royal wreath and capped it with the crown of the House of Orange as if it were any other Dutch fighter unit. For years this patch was worn on the left breast of the pilots' flight suits – the spot reserved, according to USAF uniform and appearance regulations, for the emblem of the unit's major command (TAC, USAFE or PACAF) affiliation. Additionally the unit's off-duty "bar patch" was a rendition of the Heineken beer label with the title: "32nd D.A.N.G." (Dutch Air National Guard).

Early in the summer of 1978 selected 32nd F-4 pilots were posted to Langley AFB to train on the F-15. This time the 71st TFS, under LtCol Jon I. Lucas,[14] was tasked with the upgrade of a USAFE unit and on September 13 – in a deployment dubbed Operation *Coronet Sandpiper* – he led 16 "Ironmen" and two "Wolfhounds" "across the 'pond.'" The conversion was completed in November when Col Neill Eddins (1st TFW commander) and Col Albert L. Pruden, Jr., (32nd TFS commander) taxied their "CR"-coded F-15s over to the ceremonial area at Soesterberg and turned their aircraft over to (now) LtGen Benjamin N. Bellis, now the Vice Commander of USAFE.

THE 32ND TFS AND THE FOURTH OF JULY ALPHA SCRAMBLE

The Fourth of July – Independence Day – has historically been one of America's greatest holidays every year. It is a time when Americans gather together to celebrate the freedoms they enjoy and honor the price paid to obtain and defend them. It is a time of parades, picnics, ballgames and fireworks. It is a Federal Holiday and, at overseas military bases, routine operations are shut down and the populace is invited to join in the base celebrations, which frequently include picnics, ballgames and fireworks.

It was thus on July 4, 1989, when Captains J. D. "JD" Martin and Bill "Turf" Murphy checked in at the temporary Zulu facility[15] to assume the duties of ALPHA KILO ZERO ONE and ZERO TWO. They were looking forward to a quiet day (no Tango scrambles) and as the 32nd TFS Zulu log recounts, "a good view of the fireworks." "A good view of the fireworks" they got, "a quiet day" they did not.

While most of the men, women and children associated with the 32nd TFS gathered at the "infield" between Soesterberg's runway and the "Wolfhounds"' squadron area to enjoy carnival rides, hot dogs and Heinekens, and a baseball game between Ops (the pilots) and Maintenance (the maintainers), some 500nm to the east a Soviet MiG-23M "Flogger-B" was lifting off from Runway 23 at Kolobzreg, near Gdansk, Poland, its wings out at the 18.5-degree take-off setting and the Tumansky R-29-300 turbojet roaring in full afterburner. At the controls was Colonel Nikolai Skurigin, taking off for an intercept training mission over the Baltic Sea. His "Flogger" was loaded only with 200 rounds of 23mm ammunition and full fuel tanks. Suddenly, just after raising the landing gear, at only 130–150m (about 400ft) above the ground the afterburner abruptly quit and, in his mirrors, Skurigin noticed smoke trailing his aircraft. The MiG settled into a descent and, convinced that he had an engine failure, the Russian colonel quickly ejected from his disabled aircraft.

As Col Skurigin descended safely to the ground via parachute, the MiG – its load lightened and CG shifted aft by the sudden absence of the pilot and heavy ejection seat and its Tumansky still running at a reduced power setting – pitched up slightly and began a climb. Pointed southwest the "Flogger" climbed resolutely at its trimmed airspeed of 170 knots (take-off speed), flying across the northern part of East Germany, and arrowed into NATO airspace at 35,000ft, on a heading of 230 degrees.

At this time 2ATAF had four units on QRA(I) – Soesterberg's Eagles, Dutch F-16s at Leeuwarden, Belgian F-16s at Beauvechain, and RAF Phantom FGR.Mk 2s at Wildenrath, West Germany.[16] Through the NATO E-3 AWACS (callsign MAGIC) airborne at the time, and its CRCs, the northern Sector Operations Center (SOC) saw the MiG approaching and when it crossed the Intra-German Border (IGB) the commander scrambled AK01 and 02.

BELOW
At the sound of the horn, the Eagle pilots race to their jets for a Zulu scramble. During the Cold War this scene was repeated frequently to ensure practiced readiness of the pilots and ground crews. In this case it takes place at Elmendorf AFB, Alaska, as Maj Tom Oberg dashes to his F-15C, which is loaded with two AIM-120 AMRAAM, two AIM-9X and two external fuel tanks. (USAF)

When the "Bee Bop"[17] sounded, "JD" and "Turf" initially thought that the only other "Wolfhound" on duty that day – the supervisor of flying (SOF) – was playing a trick on them, but they responded anyway and upon cranking engines, they learned from NIGHTCLUB (the Dutch Wing Operations Center or WOC) they had on their hands the launch all Eagle Drivers yearned for – an Alpha scramble. When "JD" blasted down Runway 13, with "Turf" only 15 seconds behind, the crowd of "Wolfhound" families eating, drinking and playing in the infield thought they were being given an impromptu air show in honor of the holiday!

We pick up the event from "Turf" Murphy's perspective:

> What made the 4th of July scramble different apart from the fact that it was an "enemy" MiG-23 in our airspace(!), was the extensive amount of unintentional communications jamming by our own friendly GCIs. The standard drill was: you get airborne, you contact your GCI on the TAD frequency assigned in the scramble order; you authenticate; they respond correctly; and all is well. Not that day. When we got airborne and checked in on the assigned TAD, we could not get a word in edgewise. There were at least three other GCI agencies each thinking they had control of our flight, and all four of them not hearing each other on the ground. The problem was that at our high altitude, we heard every transmission from all of them. But since all transmissions were all being "stepped on," it was very effective jamming – better than any Red Flag I ever participated in.
>
> So, due to the jamming, we were airborne for quite some time before we even knew the actual vector toward our bogey. The initial vector from the scramble order told us to go on a standard northeasterly vector (060) toward what we used to call the "Beak," on the border of East and West Germany (some 100+ miles away).[18] In fact, we had already leveled off at 35,000 and accelerated to supersonic speed on that northeasterly vector when we received our first piece of intelligible instructions from GCI. That's when were told to "snap" to the right about 60–70 degrees (off gimbals right side). Prior to the snap, our noses were pointed such that our radars were not even looking at the bogey. After snapping right, we immediately grabbed radar locks at about 17nm. Mind you, we are now going supersonic, as seconds earlier we believed we needed to be 'beating feet' to the Intra-German Border. Based on our short-range contact and incredibly fast speed, we were tally-ho our bogey in less than a minute. A short-range intercept while going supersonic, fully loaded with fuel and missiles, and being mesmerized at the sight of a Russian "Flogger" in German airspace, all combined with the "Flogger" traveling at only 170KCAS [knots calibrated airspeed] made for a challenging stern conversion!
>
> That's where the eyes play tricks on you – you know, you're looking at a MiG-23 just like the pictures you've studied your entire fighter pilot life, but it just doesn't add up. What's he doing here? Why is he alone? And why is he travelling at 170 KCAS? Meanwhile, the comm jamming just would not end! We were continually bombarded by four different agencies, unable to make out any one of them clearly. Finally, "JD" had had enough, and as boldly as he could holler into the radio, he said he would talk to only one agency (BANDBOX – the trusty Dutch GCI), and for the rest to "shut up!" Finally, the comm jamming stopped.
>
> However, the fun only intensified after IDing the jet as a "Flogger." Initially, we converted to about 2nm in trail. At that range, we could not see that the canopy, as well as the pilot, were missing. When we told GCI that we had just intercepted a "Flogger," in disbelief they responded back to us with "Say again!" And this went on at least a dozen times. "JD" would say it was a "Flogger" and they would say "Say again!" On about the twelfth attempt, I think they finally believed us. Briefly, after their finally believing the existence of a "Flogger" in their airspace, they told us to intervene[19] him into Laarbruch, an RAF Germany base which was essentially right below us at that time.
>
> Shortly after this, the "say again" routine began again with even more fervor. I stayed back at 1nm trail, heater uncaged on him, and "JD" went in for the intervention. When he got into route formation or so, only then did he know something was really wrong. The expression "Houston, we have a problem!" would fit perfectly here. "JD" explained that there is a problem – no pilot! This is when the numerous iterations of "Say again!" began again. He told them, they would not believe him, so he told them again, and they still didn't believe him, and so on. It must have taken 15 to 20 iterations of "JD" explaining that we had a canopy-less, ejection-seat-less, pilotless "Flogger" on our hands until they finally believed us. Then, and only then, did it all get eerily quiet. It was as if down below us, they were frantically looking through their QRA(I) manuals for what to do now. I suspect they found nothing!
>
> All they said was to continue to stay with him. At our initial intercept, the "Flogger" was at 35,000ft. At this point though, it had continued to climb shallowly, obviously approaching its service ceiling for the thrust

setting, and only climbing at a rate commensurate with his fuel burn. It topped out at 39,500ft, then I saw a puff of smoke and a vapour trail: it had obviously run out of gas. Then the shallow descent began.

It was at that point that GCI knew they had a problem developing real soon – a jet was going to crash somewhere in front of us – and pretty quickly. At that point we were given clearance to arm hot and to engage. However, the engage clearance was qualified with something to the effect of "only engage if you believe doing so will result in less damage on the ground than simply letting the aircraft crash on its own." "JD" and I had plenty of time to inter-flight chat on the Aux UHF. We went through several iterations of "should we or shouldn't we?" Our main concern was, "where will all the pieces go?" Would it actually make more sense to let the jet fall down to earth predictably in one piece than to break it into many unpredictable pieces by shooting it? At approximately 15,000ft, we began to finalize our assessment. The "Flogger" was heading for a city, which we later determined to be Lille, France, on the border of France and Belgium. Our conclusion was this: we had decided if we believed the jet would reach Lille, we would fire on it prior to the city limits in order to at least keep the wreckage on the outside of the city. We began to take particular note of the VVI vertical velocity indicator – measuring the rate of descent and mileage covered, and we concluded the "Flogger" would not reach Lille. It looked like it would crash in a relatively sparsely populated region short of the city. So, we armed safe and watched it crash into what looked to me like an empty field. As we got lower, we began to lose radio reception. So I stayed higher to act as a radio relay. From my vantage point at 6,000–10,000 or so, I did not even see it hit the house. "JD" went much lower and he did see the impact with the roof of the house – with the "Flogger" in a perfect gear-up landing attitude. The wreckage crossed the road and settled into the field beyond. Not much of a fire since it was empty of fuel. We stayed on scene another 10–15 minutes or so until reaching Bingo fuel and RTB'd.

LEFT
The zoom climb, though perhaps not quite as spectacular as this Holloman F-15A would have you think, was the best way to intercept high- and fast-flying Soviet interceptors, usually with a volley of AIM-7s. The white AIM-9s are left over from the days when the F-4's belly was painted the same colour. Like the gray AIM-7s seen here, the Sidewinders would also eventually be painted gray to better blend in with the Eagle. Aircraft 77-117 was an 8th TFS "Black Sheep" jet. It was passed to the 122nd FS, Louisiana ANG, in September 1991. It crashed on June 12, 1993, 30 miles east of New Orleans. Its pilot ejected safely. (USAF)

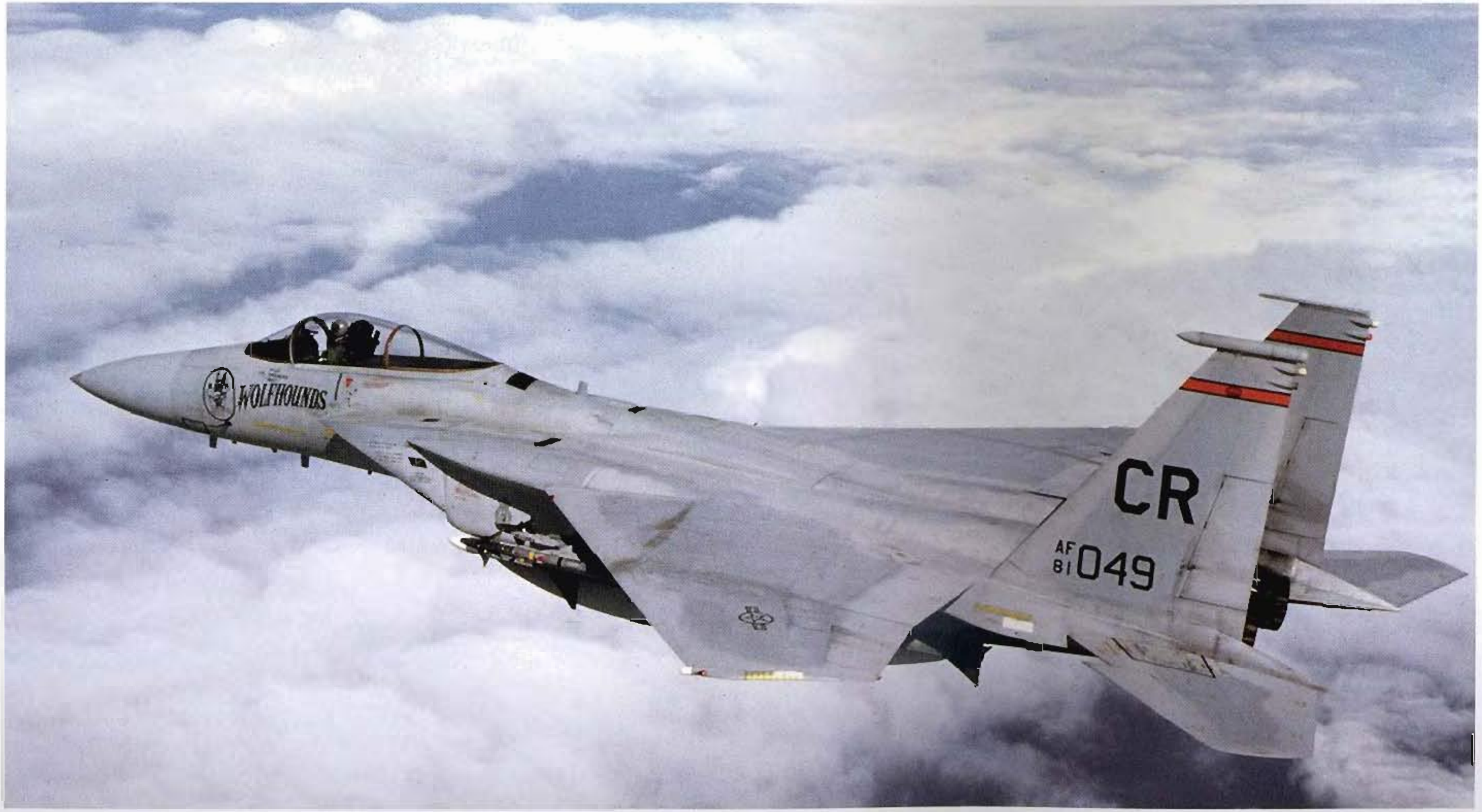
The day after his "Flogger" crashed into a farmhouse near Kortrijk, Belgium, tragically killing the 18-year-old Belgian man in the house, Col Skurigin publicly apologized, saying: "If I could have foreseen such tragic consequences to this pilotless flight, I would have stayed in the plane to the end."

The sadness of the innocent's death notwithstanding, the 32nd TFS Zulu log – usually the source of lurid details of ALPHA KILO activity – entry for the day is succinct: "Nice Alpha scramble today; but, we're under orders to kill you if we talk about it. 'JD.'"

"HOLES IN AIRCRAFT"

Following the 49th, the 33rd TFW (tailcode "EG") at Eglin AFB, Florida, was the next wing to receive the F-15. During WWII the

BELOW
Fully armed on a Tango scramble, the 32nd TFS "Wolfhounds'" flagship patrols the skies of Holland and northern Germany sometime in the 1980s. F-15 81-049 was one of the very few Eagles with authorized nose art, in this case a stylized version of the unit's Walt Disney "Big Bad Wolf" cartoon character. Eagle 81-049 was the only 32nd TFS Eagle lost, crashing into the North Sea, 9 miles off Spurn Head, UK, on April 25, 1990. The pilot ejected safely. (USAF)



33rd Fighter Group had been formed in January 1941 and trained on the P-40 Warhawk. It took part in Operation *Torch*, the Allied invasion of French North Africa, and fought across North Africa and through the Mediterranean. The Group soon earned the nickname "Nomads" because of its frequent moves, transferring to the China, Burma, India (CBI) Theater in February 1944. Its pilots shot down 139 German, Italian and Japanese aircraft in these campaigns. Afterwards it had a checkered existence as an air defense unit, moving to Otis AFB, Cape Cod, Massachusetts, in 1948, and flying F-86 Sabres, F-89 Scorpions and F-94 Starfires before being deactivated in 1957.

In 1965, the wing was resurrected at Eglin to become the "surrogate mother" of squadrons headed to combat in SEA with the latest technologies the AF was developing at the Eglin Test Ranges. The wing consisted of the 4th TFS, 16th TFS, 25th TFS and 40th TFS and was in the business of birthing special-qualification F-4 units, training the first squadrons to employ electro-optical (EO or television-guided) and laser-guided bombs. The three squadrons of the 33rd TFW "gave birth" to a total of eight combat squadrons for SEA. For example, the 40th TFS deployed to SEA three times, upon arrival becoming the 55th TFS (in 1967), 469th TFS (in 1968) and 34th TFS (in 1969). In September 1970 the "Nomads" regained their original three squadrons – the 58th TFS "Gorillas," 59th TFS "Golden Pride" (aka "Proud Lions") and 60th TFS "Fighting Crows" – flying the F-4E Phantom II. The 58th TFS – which was to become the highest scoring USAF squadron with the F-15 – deployed to SEA during *Linebacker I* and got two MiG kills on F-4s.

The first F-15B "maintenance trainer" (77-0156[20]) was delivered to the "Nomads" on September 21, 1978 with the official Eagle arrival ceremony on December 15 that year. In the following six months the wing received its full complement of Eagles, the last – another F-15B (77-0168) – arriving on June 21, 1979. While the number of aircraft remained stable, the 33rd TFW[21] proved to be a conduit through which new F-15As passed on their way to other units. For instance, of its initial complement, on average most of the "Nomads'" Eagles were passed on to the 49th TFW at Holloman AFB, NM, within six months of arrival at Eglin.

The reason for this constant state of flux was that the Air Force had to play a continuous "shell game" because of an acute lack of operable F100 engines. The stall/stagnation problem and even more significant engine maladies had reached epidemic proportions, with motors being removed for overhaul faster than they could be repaired. By spring 1979, some 1,100 of the $2m engines had been produced, yet the USAF was 90–100 motors "below zero spares." "Below zero spares" was the Air Force euphemism for having more aircraft than engines in them, spawning the phrase "holes in aircraft" rather than "engines in aircraft."

By November that year the situation was so bad that the AFSC commander, Gen Alton D. Slay, was called in to testify before the Senate Armed Services Committee. The 1st TFW was down to 35 percent fully mission capable (FMC) and consequently had failed its most recent Operational Readiness Inspection (ORI). The FMC rate TAC-wide was only 56 percent. In other words, only half of the 450 F-15s delivered to date could fly and perform their air superiority mission. Obviously, this situation required Congressional inquiry to correct.

While the 755 stall/stagnations thus far contributed to the problem, the more significant issue was that the F100 was experiencing an exceptional amount of thermal fatigue of its turbine blades due to intense heat stress associated with the rapid throttle transients and afterburner use. The logistics support for the F100 was based on the AF's traditional measure of engine life – flight hours – and its recent experience with its other afterburning turbofan, the TF30. However, the thermal stresses associated with the initiation and shutdown of afterburner was causing a lot more damage than time airborne (the traditional yardstick for measuring engine wear). Going from idle (below 73 percent power) to maximum (above 89 percent power) and back to idle was one "transient cycle" and the F100 was designed to withstand 3,530 cycles per 1,000 flight hours. What no one foresaw, however, was the fact that in air combat training (and actual air combat if need be) with engines that had an extreme power advantage over those of the adversary, frequent throttle modulation (in and out of A/B) was required to control airspeed and overtake to get the kill. As a result, the Eagle's F100 engines were averaging 12,500 cycles per 1,000 hours, or almost four times the abuse P&W had anticipated. Consequently, when the engines were being removed for their 100-hour inspections, instead of the expected 20 percent condemnation rate for the first stage turbine

ABOVE
Four 58th FS "Gorillas" F-15Cs transit back to their home at the base of the Florida panhandle. The 33rd Fighter Wing's status as a tenant unit on an AF Systems/Materiel Command base sometimes made life difficult for the three fighter squadrons. Just under the nose of the third jet (the 58th FS flagship) can be seen the long "Nomads" runway at Eglin AFB. (Steve Davies: www.fjphotography.com)

blades, 60 percent of the blades were distressed beyond limits. Since the spare parts supply was planned based on the much more tamely operated TF30 (1,500 cycles per 1,000 hours in the F-111), the stockpiles of spares were soon exhausted.

To make matters worse, two of P&W's parts vendors – one bearing manufacturer and a forging supplier – went on strike, slowing the production line to the point where replacement engines were not delivered in time. Consequently, when brand new F-15s were rolled out of the St. Louis factory and flown to the Warner-Robins Air Logistic Center, the F100s were pulled out and shipped back to St. Louis to be put in the next Eagle off the assembly line so it too could be flown out and placed in temporary storage. In the summer of 1980 some 43 F-15s (and 53 brand new F-16s) were without engines.

"Knock It Off, Knock It Off – Stall/Stag!" The Achilles Heel of the Eagle

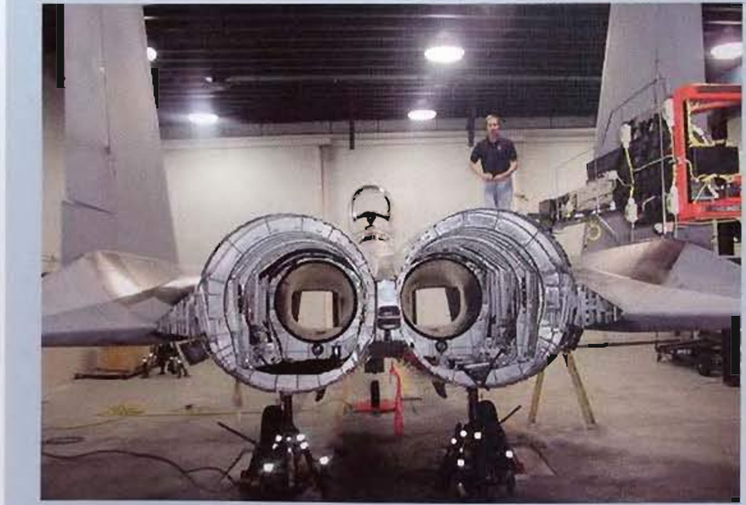
On June 15, 1978, a 53rd TFS F-15A, 75-0059, from Bitburg was wrapped up in ACT over the North Sea when first one F100 engine, then the other "burped" into a stall and progressed into a full-blown stagnation. With both engines' RPMs rolling back and FTIT temperatures going through the redline, the pilot knocked off the engagement and began the procedures to recover the engines, essentially now having found himself in a 20-ton glider over the open sea. Unfortunately, neither engine was able to restart before he reached the "uncontrolled ejection altitude" and pulled the handgrips of his Douglas Aircraft Corp ESCAPAC IC-7 ejection seat. It was the first time the malady of F100 stall/stagnation had caused the loss of a $20m jet.

The Eagle's exceptional performance was derived from the Pratt & Whitney F100, which employed a strong, fuel-efficient, high-bypass turbofan and an explosive, high-thrust afterburner. This mating also had the potential to literally tear the union asunder. On occasion, the phenomenon of stall/stagnation attempted to do just that.

While the F100 experienced other difficulties, such as slow acceleration while trying to "spin up" the heavy multi-stage set of fan disks, it was the afterburner that was prone to a host of difficulties, such as A/B blowouts (initially lighting but the power of the eruption actually blowing the fire out the nozzles and simply leaving a trail of jet fuel vapour behind it) at slow speed, unpredictable and unreliable A/B lights at other speeds and "hard starts" at higher altitudes and low speeds. The last mentioned accounted for 75 percent of the stall/stagnations up to 1980.

The cause of the initial stall condition was usually the combination of turbulent, slow speed air entering the face of the engine (commonly at high AoA and low speed in "knife fight" kind of maneuvering with an adversary) and an eruption of backpressure in the A/B section (from the "hard light off"). The VG inlets, lagging the dynamic and dramatic airflow changes of the vicious maneuvering contributed to the former, while the EEC's inability to open the A/B nozzles fast enough to prevent the explosive rise in backpressure from A/B ignition most often resulted in the latter. Thus, most stall/stags were caused by both a disruption of airflow on the face of the engine (which, of itself a severe case, would rarely cause more than a temporary compressor stall) and a sudden and intense "pressure spike" coming from the rear. Unfortunately the fan bypass ducting around the "core engine" provided a convenient path to transmit this sudden high-pressure pulse against the backside of the fan blades. Once this hot pressure spike entered the fans from the rear, it mingled with the air coming through the fans to enter the compressor section of the "core engine," feeding violently disrupted, intensely hot air into the combustion chamber. In this circular path from A/B back into core engine, the F100 began to "eat itself" slowly winding down in RPM while temperatures rose dramatically.

Normally below 25,000ft, at all speeds, the engine would operate correctly, provided the EEC was "trimmed" properly. Above 25,000ft and below 250KCAS, the Eagle Driver had to be careful shoving the throttles into A/B, pushing it into the first stage, hesitating while it lit off, then adding power slowly (using about one inch per second throttle advance), if not, "failure to light, rumble or blowouts may occur." Above 30,000ft and below 170KCAS (about .6 Mach or less), "failure to light, rumble and blowouts are probable."



LEFT
During late 1979 and all of 1980, the Eagle force was hamstrung by a lack of F100 engines. Some two squadrons' worth of new F-15s were stored at Warner Robins Air Logistics Center and since they looked like this – you could see all the way through them – they prompted the phrase "holes in aircraft." (USAF)

If we heard an engine "cough" or "burp," fast action was required. First, we looked at the nozzle gauges to see which engine had the problem (and hoped it was only one), then, if in A/B, immediately brought the throttle back to MIL. Many times, just terminating A/B use would clear the stall. Then we checked the FTIT gage. If the temperature were rising the stall had progressed into the combustion section, and the resulting unstable burning would cause rising temperatures while the RPM "rolled back" to less than 60 percent. In this case, we would chop the throttle to IDLE. If the FTIT continued upwards, it was throttle OFF and wait to perform a restart. Meanwhile, the pilot would dump the nose and dive down to increase airspeed (250KCAS minimum, 350KCAS desired) and correspondingly the airflow through the engine. Once the engine had cooled off a bit (FTIT below 700°C) and with the "windmilling" rpm between 25 and 40 percent, he would bring the throttle back to above IDLE and watch for an RPM increase.

If things went really badly and the engine refused to restart, the JFS could be started (after jettisoning any external stores or pylon on the centerline station to open the inlet for better airflow) and a normal "engaged" start could be attempted. The pilot of 75-0059 did not have this option, since the McAir designers never expected both engines to have problems at the same time. Following this expensive loss, the JFS circuitry was modified to allow its use in flight.

As a result of the rash of stall/stags in the first few years, P&W attempted several "fixes" to alleviate the debilitating malfunction. These included a slight hesitation in the A/B light, giving the EEC time to open the A/B nozzles in anticipation (relieving the sudden pressure spike) and reducing the initial fuel flow for light off (which minimized the extent of the A/B eruption). Additionally a sensor loop was established that would change the afterburner settings upon sensing a stall. These were incorporated in all subsequent production engines and retrofitted in existing F100s during depot maintenance.

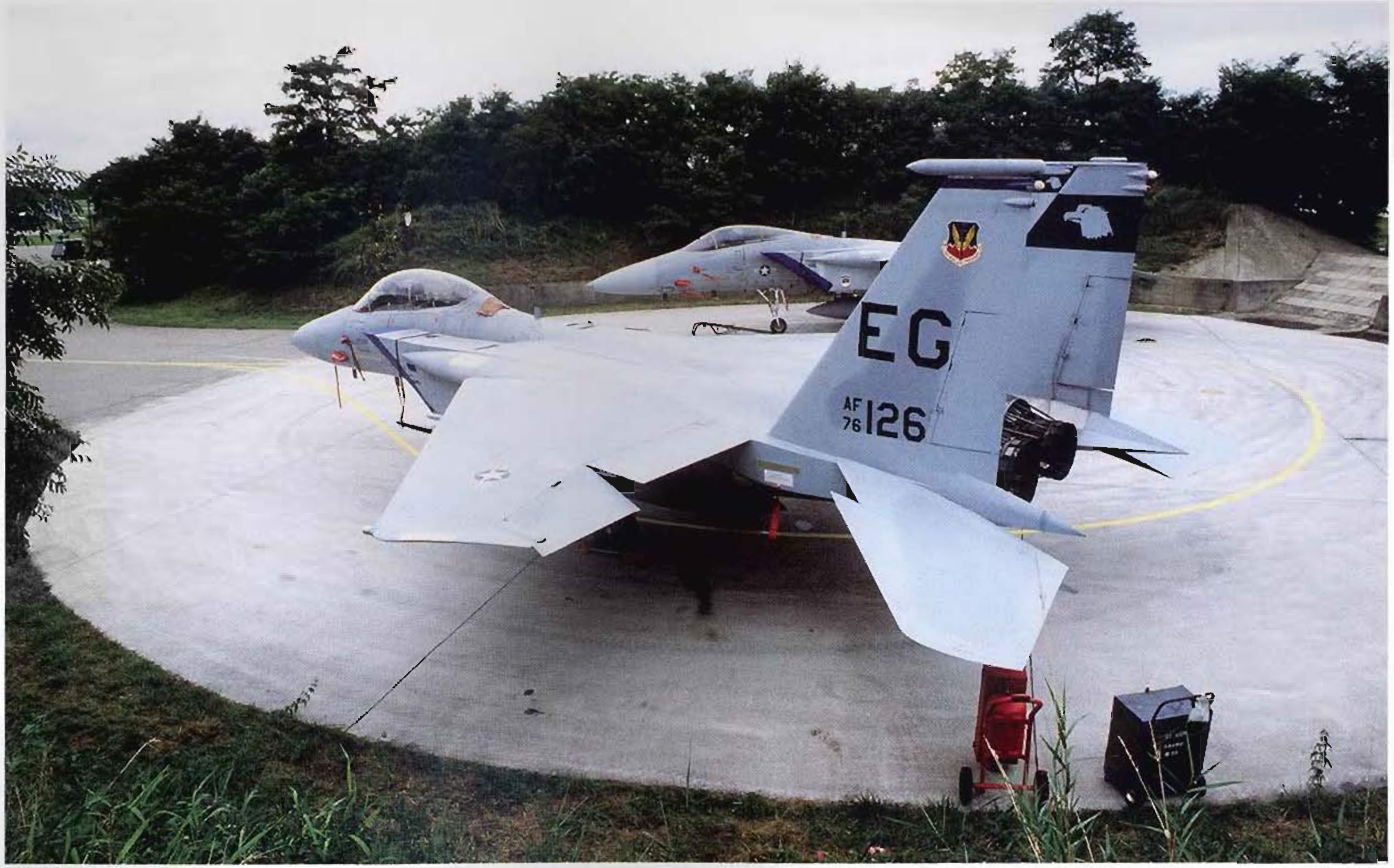
There was one other change to the P&W motors, at least at Bitburg. Since 1925 Pratt & Whitney had proudly affixed a medallion (originally bronze, now ceramic) to its products, displaying the company name above a soaring eagle, wings spread in flight, below which was its slogan: "Dependable Engines." At Bitburg in the early 1980s these were removed wholesale.

P&W eventually solved these issues, accelerating F100 production by 75 units in 1980, and the number of sidelined Eagles was reduced to 31 by November that year and was eliminated entirely in 1981. Meanwhile, the AF, for its part, extended the life of its operable motors by reducing operating temperatures by 80°C (and significantly reducing the engine's thrust in the process). This huge problem – though temporary – had a deleterious result on the F-15 force at unit levels during 1979–81, effectively reducing the USAF's complement of Eagles by two squadrons' worth of fighters.

As a consequence, it was decided that the most recently equipped unit, the 33rd TFW "Nomads" would return to its former role as the "birth mom" to the next Eagle wing, this time Kadena's 18th TFW. While the 58th and 59th TFSs maintained the Wing's combat capability, the 60th TFS "Crows" began to receive the new and far more powerful C-model, but only to get another unit operational on the type.

READY EAGLE III AND A BETTER EAGLE – THE F-15C

PACAF's 18th TFW (tailcode "ZZ") was the only wing to receive C-models as its first – and only – version of the Eagle. The first F-15C delivered to an operational unit (78-0470) was accepted on July 3, 1979 by the 60th TFS at Eglin, the squadron tasked with preparing the Kadena squadrons to operate their new jets. Having begun training 18th TFW aircrews and maintenance personnel 18 days earlier, the "Crows" got the first squadron – the 67th TFS "Fighting Cocks" – ready to deploy 16 F-15C/Ds (three were already there as maintenance trainers) to Okinawa on September 26 that year. By April 16, 1980 the 33rd TFW had sent two more fully equipped squadrons to Kadena, having trained 55 MR Eagle Drivers (and two MC pilots), transferred 54 F-15C/Ds to Kadena and begun reverting back to the older, less capable F-15A.[32]



ABOVE
The 58th TFS "Gorillas" was the first 33rd TFW squadron to convert to the F-15A/B. Having deployed to the Netherlands to become acquainted with NATO procedures, here two 58th TFS jets rest in a revetment at a Dutch base. F-15B 76-126 had originally been a Bitburg Eagle and was transferred to Eglin when the 36th TFW received its new C-models. In 1985 this jet went to the 48th FIS, then in 1992 to the 110th FS, 131st FW, Missouri ANG. (USAF)

OPPOSITE
While the various frontline Eagle squadrons and wings continued to hone their skills in employing the Eagle to the maximum effect, the Fighter Weapons School was busy taking Eagle pilots and training them in the minutiae of the Eagle's capabilities and weapons, and the latest in tactics. These "WA" tailed F-15As wear the revered yellow/black checkered tail flash that is synonymous with the very best the USAF has to offer. Both of these jets were passed on to the 110th FS, Hawaii ANG. (USAF)

The 18th TFW had been assigned to the Pacific since its establishment in Hawaii in 1927. As the 18th Fighter Group, the unit fought the Japanese in the Solomons using the out-classed Curtiss P-40 Warhawk, and over New Guinea with the twin-engined Lockheed P-38 Lightning, eventually moving into the Philippines where it remained after the war. The Group, in combat from Pearl Harbor to V-J Day, had accounted for 237 Japanese aircraft destroyed. In July 1950 the 18th found itself in combat once again, in Korea, flying North American F-51 Mustangs in the close air support role until receiving F-86 Sabres early in 1953. Becoming the 18th FBW, the unit

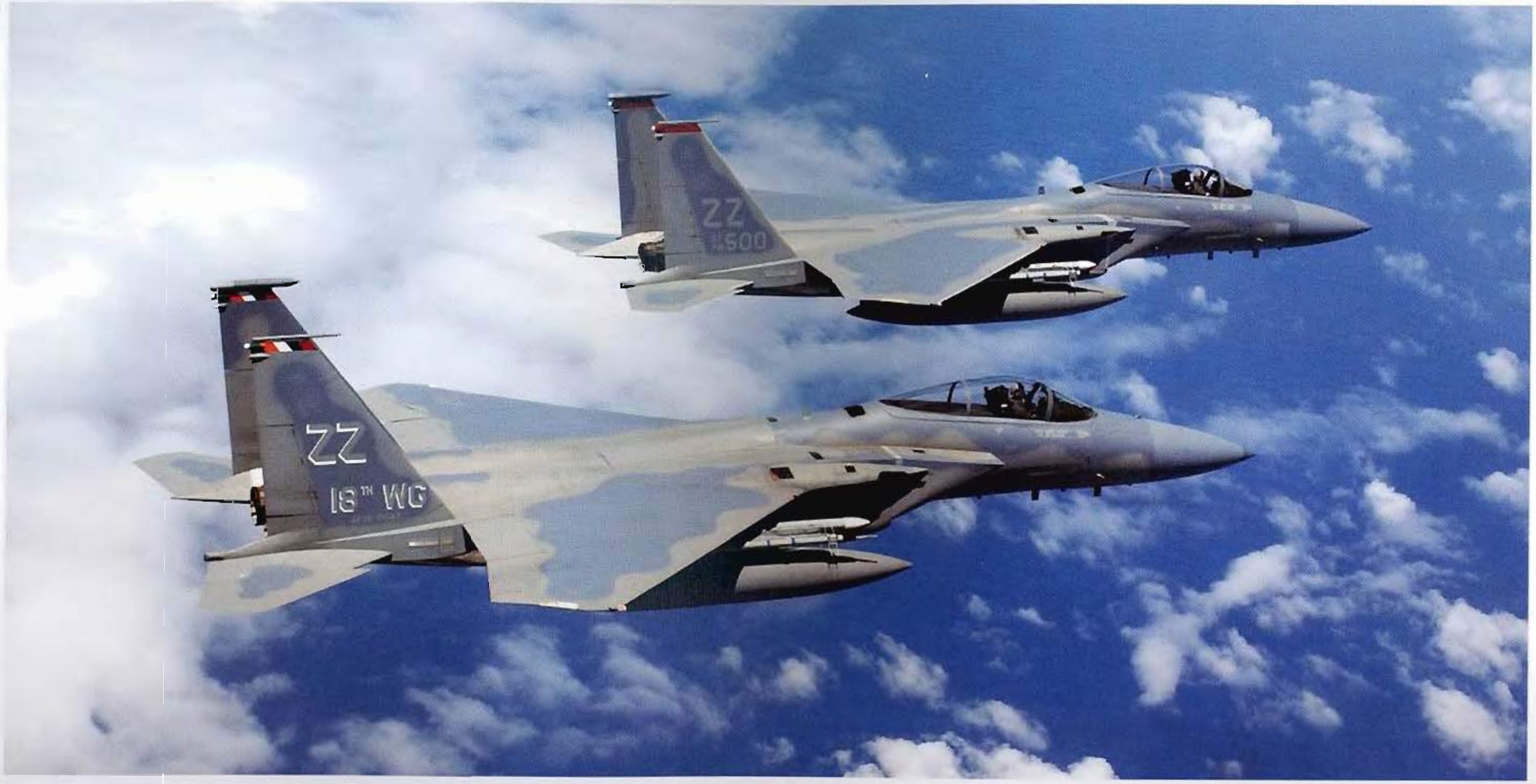
WA
AF
76 120
WA
AF
76 119

moved to Kadena AB, Okinawa, in November 1954, transitioning through the F-100, F-105 (which it flew extensively from RTAFBs during SEA), and F-4D Phantom IIs. The Wing consisted of the 12th TFS "Dirty Dozen" (until November 1999, by which time it was the 12th FS), 44th TFS "Vampires" and the 67th TFS "Fighting Cocks" and remained largely equipped with the early C-model (with the MSIP upgrade) Eagles it was initially assigned.

The new F-15C, for the first half of its service life, was the definitive version of the mighty Eagle. While externally it appeared very little different, there were significant interior modifications making a powerful air-to-air fighter even stronger. McAir engineers had built in significant room for growth and the C-model took advantage of that available space. One of the most significant differences was in internal fuel capacity and the ability to carry conformal fuel tanks. Internally, the two wing and main fuselage tanks were increased to hold an additional 1,950lb (300US gal), upping total capacity to 25,350lb. Also, while it did not prove significant for most US units, the C-model came equipped with the plumbing, pneumatics and electrical connections to carry Conformal Fuel Tanks (CFTs), called "saddlebags" because of the way they hung on the flanks of the

BELOW

Two 18th Wing F-15Cs formate over the Pacific. The "Wing King's Jet" (wing commander's aircraft) is 78-543. Aircraft 78-500 served with all three F-15C squadrons at Kadena and was on strength with the 67th (red tail) FS in 2006. Both aircraft are shown carrying AIM-120s and the KITS training pod. (USAF)



jet. These added the potential to carry an additional 9,800lb and fly for 5 hours and 20 minutes – and a truly significant distance – without external tanks or air-to-air refuelling (AAR).

The total fuel carriage capability of the F-15C was 35,100lb. In order to lift this much gas, most of the airframe structure required beefing up, increasing the empty weight of the aircraft by 1,500lb to 29,000lb total. This in turn required a much more robust landing gear to support it on the ground. The F-15A was limited to a maximum gross weight of 56,000lb. This meant that the A-model could carry a full armament load, but with only two external fuel tanks – or it could leave behind a couple of AIM-7s and fly further using three "bags of gas." In order to carry a full armament load, CFTs and three fuel tanks, the airframe and landing gear of the "C" were beefed up to allow a maximum gross weight of 68,000lb.

Additionally, the landing gear was mounted slightly differently on the C-model. The vertical alignment of the A-model's gear made it tricky to land in high crosswinds since the breeze could easily lift the upwind wing, tipping the aircraft to one side and causing it to drift towards the runway edge. The C-model's legs were angled outward about 4 degrees, barely enough to be discernible but enough to keep the jet from "tipping over" in crosswinds. Thus the most significant visual difference in the early model and the definitive version was in the landing gear. Additionally, early A-models initially had black-painted hubs on all three wheels, but they reverted to white ones when the C-model wheel and brake assemblies were retrofitted to the entire Eagle fleet.

Other internal differences could only be appreciated from the cockpit. Beginning with the radar in the nose, the APG-63 was provided with a programable signal processor (PSP), enabling the upgrading or modification of the radar's search and tracking logic by means of changing a computer tape. Additionally the radar data processor (radar's internal computer) memory was increased from 24.6K to 96K. This allowed the radar to "remember" the location and vector of one target while the pilot locked up another and could transfer the lock back and forth between two targets.

Other enhancements included Doppler beam sharpening (DBS), a high-resolution Raid Assessment Mode (RAM), selectable ground moving target indicator (GMTI) and improved electronic countercountermeasures (ECCM) features. DBS allowed the radar to see more detail in the air-to-ground mapping mode. RAM theoretically allowed the pilot to see the formation of an incoming raid. GMTI was a speed threshold set by the pilot to eliminate ground targets that were moving at velocities significant enough to generate a target, such as German BMWs and Mercedes scorching up the autobahns.

Behind the radar, the CP-1075 CC was also significantly upgraded to a 34K high-speed digital "general purpose" computer over the original "hard wired" 24.6K analog computer. In addition to the weapons envelopes permanently stored in this expanded memory, it could be reprogrammed using operational flight program (OFP) updates. Thus changes in the weapons envelopes, anticipating the arrival of the AIM-7M and AIM-9M, could be accommodated with minimum effort.

The new CC also enabled the overload warning system (OWS) that gave the pilot an aural tone to indicate how close to maximum *g* he was pulling. The more robust F-15C airframe was rated to 9*g*s, with the exception of one small spot in the flight envelope, known as the "thumbprint" because of its size and shape on the flight performance graph. Because of certain flex and

BELOW
Here a 67th TFS F-15C (78-527) visits a JASDF air base, most likely Nyutabaru, the main JASDF training base, as evidenced by the mix of Japanese F-104J, F-4EJ and F-15J fighters, and a T-33A. (Warren Thompson via Doug Dildy)

LN
0178
LN
493 FS
LN
010

ABOVE

When the Eagle finally entered service, the Air Force prioritized its introduction to West Germany to play a key role as protector of NATO from the Communist Soviet Union and the Warsaw Pact in general. With the Cold War over by 1989, USAFE's F-15s were eventually sent to RAF Lakenheath to replace the F-111F Aardvark bomber. Retracing the steps of their forefathers, a three ship of F-15Cs belonging to the 493rd FS, 48th FW, formate over the white cliffs of Dover. It was over this iconic landscape in the summer of 1940 that volunteer "American Eagle" pilots took to the skies to help fend off the German Luftwaffe's attack on the UK mainland – The Battle of Britain. (Steve Davies: www.fjphotography.com)

torsional loads on the wings, the maximum *g* in the thumbprint was 7.33. The inability to know when the aircraft was in the thumbprint versus when it was in the larger part of the envelope had previously limited the F-15A to 7.33*g* at all points in the flight envelope. Now the CC, by knowing the flight dynamics (from the air data computer) and *g*-being pulled, and comparing these to the envelope parameters stored in its memory, could tell the pilot how he was doing relative to the maximum allowable *g*, even in the dynamic and rapidly changing environment of air-to-air maneuvering. No matter what the speed, at 85 percent of the allowable *g* a "slow-rate beeper" (four beeps per second) would begin to sound in the pilot's headset. Pulling a little more, through 92 percent the beeper would go to "high rate" (10 bps). If the allowable *g* limit for that flight condition were exceeded, "Bitchin' Betty" would announce "Over *g*, Over *g*" and continue to do so until the *g*s were released back below the limit. OWS was an exceptional BFM tool, telling the pilot near-exactly how many *g*s he was pulling and thereby aiding him at maneuvering at near maximum *g* – now increased to 9 – all the time.

Also included were two new UHF radio modifications. First was the jam-resistant, frequency-hopping RT-1145C/ARC-164 Have Quick (beginning with 80-002 and retrofitted to all previous C-models). Synchronized with other flight members' (and AWACS) radios, the UHF hopped around a net of selected frequencies to foil most conventional communications jamming techniques. The second was the encrypted KY-58 secure speech radio (installed in the same jets as Have Quick). The KY-58 scrambled voice transmissions and unscrambled radio calls from other KY radios so that critical, exploitable information could be exchanged without worry of being compromised by the bad guys eavesdropping on the conversation. For improved training a 30-minute VTR system was built in to record audio, VSD and/or HUD to allow debriefing of flight maneuvering, tactical communications and weapons parameters of engagements. There were many other minor improvements and a few more major ones hardly noticed by the pilot such as improving the fuel transfer system and improved braking, to handle the higher weights of the C-model.

While the 18th TFW was the first USAF wing to be equipped with the improved Eagle, in Europe, the 32nd TFS was the first unit to upgrade to the F-15C, its first three jets arriving on June 13, 1980. The 36th TFW's "Bulldogs" quickly followed suit, beginning the conversion in December 1980, the last A-model departing Bitburg in January 1981. Stateside, the 94th "Hat in the Ring" Squadron was the first TAC unit to receive the C-model, attaining IOC on November 4, 1981.

AK
AF 74 105

07

DEFENDING THE HOMELAND: AIR DEFENSE AND ALASKAN EAGLES

TOP COVER FOR AMERICA

Once the tactical commands were fleshed out with Eagles – three operational wings Stateside in TAC, one wing and a squadron in USAFE, and a wing in PACAF – and early A-models came available as the new, more powerful C-model rolling off the St. Louis assembly line replaced them in the TAF, the USAF could finally turn to increasing its air defense capabilities at home. Even until the early 1980s, Continental US air defense was provided by NORAD's fleet of obsolete Convair F-106 Delta Darts on what was known as the Northern Tier and two squadrons of dated F-4E Phantoms on the forward flanks in Alaska and Iceland.

Since Alaskan Air Command (AAC) was the force that would first meet Soviet bombers coming over the North Pole from their bases in Siberia, it was slated first for upgrade to the Eagle. The first AAC Eagle unit was the 43rd TFS, an F-4E air defense unit that had been a part of the 21st Composite Wing since 1970.[1] On March 1, 1982 the squadron received its first F-15As (mostly FY74 models, many of them from the 1st TFW as Langley received its new C-models) and converted to the Eagle over the next six months while maintaining alert detachments at Galena and King Salmon Air Force Stations (AFSs) as well as Eielson (Fairbanks) and Elmendorf (Anchorage) AFBs. The last Phantom departed Alaska on November 16, 1982 and eight days later two F-15s scrambling from King Salmon intercepted a Soviet Tu-95KM "Bear-C," the first meeting of the Eagle and the "Bear."

For several years the 43rd TFS was solely responsible for the defense of airspace from the North Pole to the end of the Aleutian Islands chain, a territory of some 586,000 square miles. To assist, in 1987 there was both a quantitative and qualitative upgrade to the northern air defense of the US. On May 8, the 43rd was joined by the 54th TFS "Leopards."[2] This additional unit was made possible by the availability of much more capable F-15Cs from Langley's 1st TFW as the "First Fighter" upgraded to the new MSIP-C. About this time the 43rd also received its first C-models from Langley and transferred its old A-models to the 199th FIS of the Hawaii Air National Guard.

On December 19, 1991 the 21st Control Wing (CW) was redesignated as the 3rd Wing as General Merrill A. "Tony" McPeak, CSAF, sought to retain "the most historic" unit designations during the post-Cold War drawdown.[3] A little more than two years later, on January 1, 1994, the 43rd FS designation was changed to the 19th FS "Gamecocks."[4] This coincided with the receipt from Eglin of the 33rd TFW's "special MSIP-Cs" which had the more advanced APG-63(V)1 radar and improved PW-220 engines.[5] For less substantial reasons, six years later the 54th FS "Leopards" was also renumbered. On April 28, 2000 it became the 12th FS "Dirty Dozen" (historically one of Kadena's 18th FW squadrons) and was

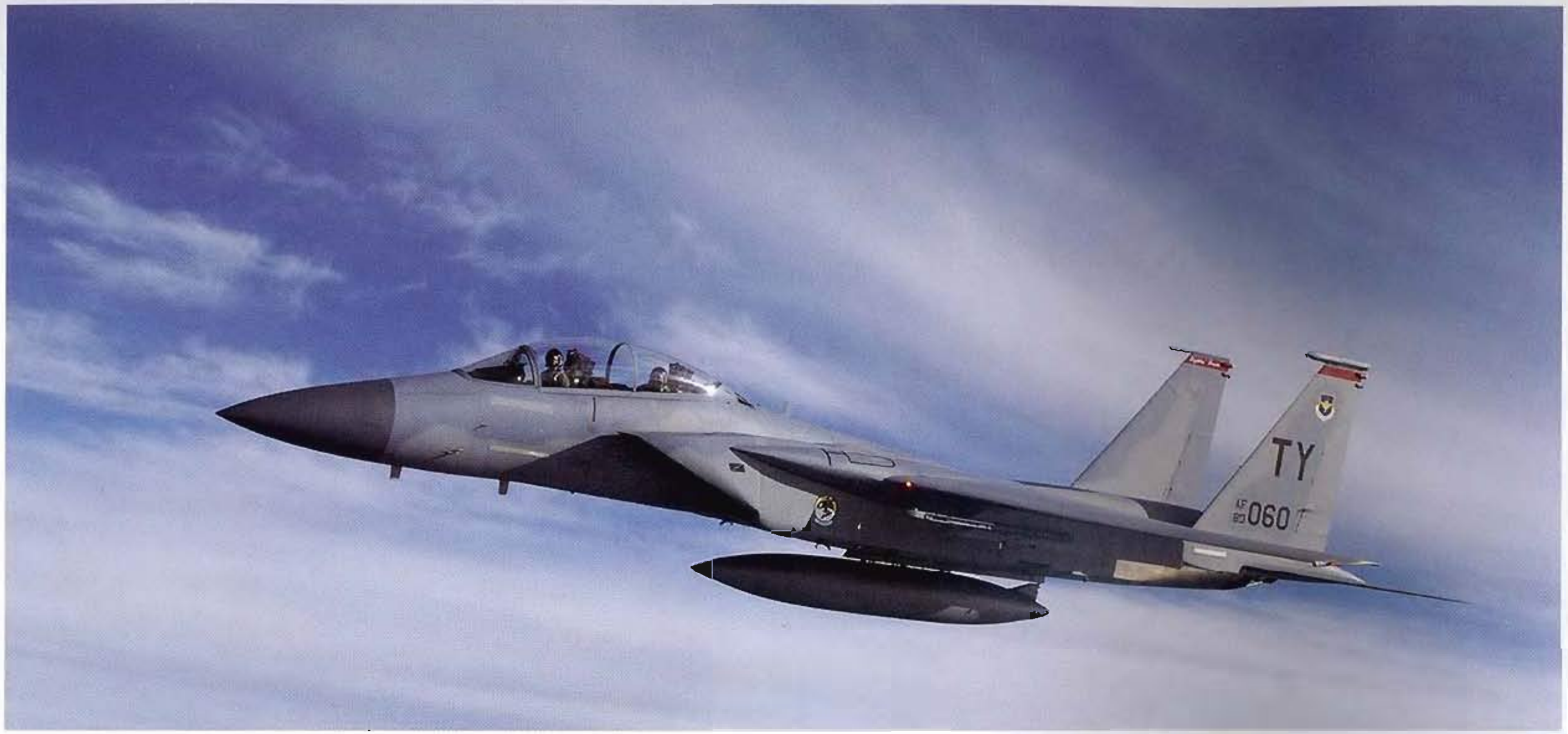
OPPOSITE
The "three bag" configuration gave intercept Eagles the ability to escort a probing Soviet bomber for as long as was usually needed. Maneuverability was diminished in such a configuration, but the Eagle was still pretty sporty. This 43rd TFS F-15A was up from Elmendorf AFB, Alaska. (USAF)

ABOVE
The 43rd TFS "Polar Bears" was the first squadron in Alaska to fly the Eagle. The unit received most of its early F-15As from the 1st TFW when Langley received its new F-15Cs. Both these jets were transferred to the 199th FIS, 153rd FIG, Hawaii ANG in November 1990. Both subsequently went to AMARC. The F-15A was unable to take-off with "wall to wall missiles" (four AIM-7 and four AIM-9) and "three bags full" (of fuel). If such a stores configuration were required, the jets would blast off from Elmendorf AFB with one or more empty external tanks, hit a tanker to top off, and then range out to intercept the Tu-95 "Bears" probing the USAF's Alaskan defenses. (USAF)

re-equipped with the new APG-63(V)2 Active Electronically Scanned Array (AESA) radar, a big improvement over the standard APG-63. By this time, the 3rd Wing had grown to also include two E-3B AWACS (962nd AW&CS [Airborne Warning & Control Squadron]), 21 F-15Es (90th FS "Pair o' Dice"), a squadron of 18 C-130H transports (517th AS [Airlift Squadron]), and three C-12F/J HQ liaison and communications aircraft.

When asked what it was like to fly Eagles in Alaska, Capt Greg "Lava" Moulton responded,

> I remember my first flight, on December 6, 2004, a local area orientation ride to Eielson AFB with a stop in Susitna MOA on the way home for some BFM. The entire trip to Eielson I couldn't keep from staring at the vast mountain ranges that stretched farther than I could see at 31,000ft, and then there was Mt McKinley. When you fly an Eagle you feel pretty commanding sitting in the cockpit, but with Mt McKinley as the backdrop it feels like you're on top of the world. And



ABOVE
The most important acquisition TAC obtained when it took over the USAF's air defense assets was Tyndall AFB in Florida. It quickly established the 325th TTW there and began moving the Eagle RTU to the Gulf Coast base. Here 1st FS "Fightin' Furies" (later called "Griffins") F-15D 80-060 (formerly an "FF," "BT" and "CR" jet) shows off its new Mod Eagle paint scheme and Gunship Gray. (F.S.36118) radome. (USAF)

doing BFM with Mt McKinley as the backdrop puts everything into perspective. From that first flight, I knew that flying Eagles in Alaska would be a lifetime experience, and every flight thereafter I have seen more and more of Alaska; to include glaciers, volcanoes, icebergs, moose, bear, and the Arctic Circle.

Any fighter pilot flying in Alaska can attest to the sights, but when it comes to the equipment you fly, nothing holds a candle to the Eagles flown by the 12th and 19th FS. From day one when I walked in the door to start my MQT (mission qualification training) I was flying the best Eagles in the USAF inventory with the newest toys. On the outside, all Eagles look the same, but "Elmo" Eagles had every upgrade available, -220 engines, JHMCS, AIM-9X, FDL, and a mix of V(1) and V(2) radars. Coming from Tyndall and having only flown with -100 engines and V(0) radars it was definitely a big step up. I was just a brand new wingman with all of 70 hours in the Eagle, but I felt there was nothing we couldn't handle with this mix of jets.

Despite the capability of our jets, we still practice and employ like every other Eagle squadron in the CAF [Combat Air Forces, the follow on name for the Tactical Air Forces]. We plan our training in cycles, upgrades aside, to prepare for large force exercises [LFEs] like *Red Flag* or *Cope Thunder*. We would usually start with BFM of all varieties during one of our surges. During the surge I usually get three flights in a day and usually fly two or three days in a row. When you fly nine times in three days you get really good at BFM. Next we would move to ACM to practice two-ship visual maneuvering against a single bandit, going for the quickest kill. After we have mastered ACM, we would shift our attention to tactical intercepts, the bread and butter of being an Eagle Driver. We culminate our training by flying DCA [Defensive Counter Air] and OCA [Offensive Counter Air] missionized scenarios.

Elmendorf is lucky when it comes to flying in LFEs because there are three fighter squadrons here and our own AWACS on base with two more fighter squadrons (18th FS "Vipers" and 355th FS "Warthogs") and a dozen Alaska ANG KC-135s up north at Eielson. Combine all of these assets in an airspace that rivals the *Red Flag* ranges with our own threat emitters (SA-2, SA-3, SA-6), and you can understand why *Red Flag North* is the new rage for the Chief of Staff of the Air Force.

Pushing out on an OCA strike as an eight-ship of Eagles walled up a "wall of Eagles" with 1.5 to 3 miles between jets making a "wall" as much as 16 miles wide with a dozen or more strikers depending on us to clear a path to the target is one of my favourite missions (that and flying a clean BFM surge). You look left, you look right and all you see is Eagles, glance at the radar and see the bandits massing to attempt to repel your attack. This is the last few seconds of calm before the fighting starts. As long as everybody got their group sorted and targeted and made them go away or die it would be a good day, otherwise we would have a lot of mopping up to do in the target area. Either way it is a rage and you are going a mile a minute (mentally) until all the strikers have called "safe." Words can only begin to describe what an OCA mission is like.

In addition to the standard Eagle squadron responsibilities, the 12th and 19th are tasked with cruise missile defense and alert (NORAD and Operation *Noble Eagle*). To guard the Northern Tier the 3WG has three Eagles and two pilots on 15-minute alert. Sitting alert put a new twist on my short Eagle career. Until my first alert tour, I had never even seen a live missile, let alone flown with four of them loaded on my jet, and 940 rds of 20mm. When the klaxon went off for the first time my heart was racing fast as I struggled to zip up my g-suit and sprint out to the jets waiting in the hangar. It was like nothing I had ever done, because this was real world, real mission, real weapons. From the time the klaxon sounded and my landing gear was in the well, was only seven minutes! Talk about hanging on by the tails! But it was a blast! Jets were breaking out of the pattern and going around on short final as we rolled onto the runway lit the blowers and blasted off in two mile trail. As we got our orders it turned out to be just a practice scramble, but to me it was as real as it got. As much as everyone complains about sitting alert, I always felt important and proud because we are the first line of defense.

GUARDING THE NORTHERN TIER

For most of the Cold War the air defense of the United States – at least for the contiguous (from Alaska, called the "lower") 48 states – was entrusted to the able air and ground crews of Aerospace Defense Command. As mentioned earlier, considerable effort and aviation technology was invested in providing ADC with the most advanced interceptors developed in the 1950s, culminating in the supersonic Convair F-106 Delta Dart. They were assigned to various FISs which were strung out across the breadth of the nation at bases just south of the Canadian border. Primarily SAC bases, these were collectively known as the Northern Tier and were well-sited for intercepting Soviet bombers penetrating the Distant Early Warning (DEW) line of remote radar stations strung across the far north of Canada.

However, with the Soviets' increasing reliance on ICBMs in the 1960s and from having only a modest (and gradually decreasing) long-range nuclear bomber force (known as Long Range Aviation or LRA), the need for a host of interceptor bases dwindled and ADC lost its relevance as a separate command. On October 1, 1979 – still flying F-106s – it was subsumed by TAC, its Colorado Springs, Colorado, HQ (co-located with NORAD) being retitled Air Defense Tactical Air Command (ADTAC). As this ambivalent name would suggest, it was a confusing period when TAC was incorporating ADC assets into its own fold. This began by moving ADTAC HQ to Langley on June 1, 1981.

One of the next moves was to give ADTAC an Eagle squadron and base it – where else – at Langley AFB, Virginia. The 48th FIS[6] had been stationed at Langley since January 14, 1953, operating F-84 Thunderjets initially, F-94 Starfires (1953–57), F-102 Delta Daggers (1957–60) and finally F-106 Delta Darts. With this series of jets, it was responsible for intercepting intruders approaching the US Air Defense Identification Zone (ADIZ) from out in the Atlantic.

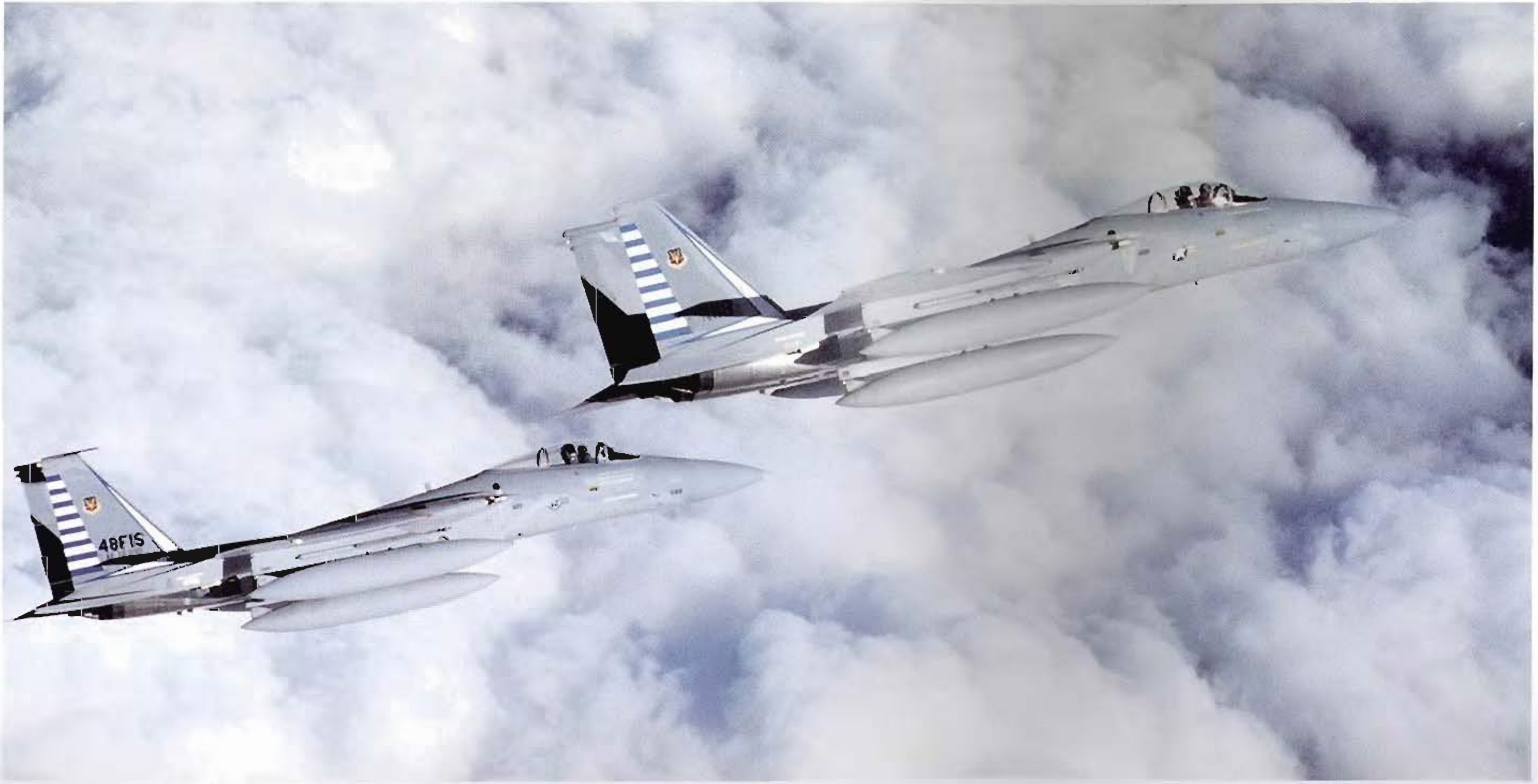
The 48th FIS received its first Eagle (76-0087) on August 14, 1981 and officially converted to the F-15A (aircraft being relinquished by the co-located 1st TFW) on April 5, 1981, the last Delta Dart having departed for the "boneyard" four weeks previously. While the "orange flight suits"[7] missed their beloved "Sixes" they were soon impressed with their new mount. LtCol Garth Granrud, a veteran of almost 800 combat hours in Vietnam (as a forward air controller and

F-4D pilot), and experienced in both the F-102 and F-106, was the 48th FIS Operations Director in the 1980s. He recalled that,

> the biggest difference between the F-106 and F-15 was the fire control system ... The weapons system in the F-106 was labor intensive. We had a semblance of HOTAS to help out, but it really wasn't as good as the F-15's. We had no auto-lock modes; everything was done manually and required a lot of 'heads down time.'

Granrud added,

> The APG-63 was a real revelation. When we locked up a target we now had all this information which previously had not been available to us: speed, altitude, heading, closure velocity, etc. In the F-106 I'd have had to have figured this all out in my head, based on raw data appearing on my radar scope. Now that we have vector sticks and such, radar interpretation is pretty easy. Prior to the APG-63 I had to manually tune my radar or it was useless, it would not discriminate



BELOW
ADC Eagles were the most colorful of USAF jets as these two 48th FIS F-15As clearly show. They are 76-117 (48th FIS flagship) and -118, both received from the co-located 1st TFW. After their stint at Langley, both went to Holloman, thence to the 110th FS, Missouri ANG. They were in the air together again on a training mission on August 19, 1999, when they collided. Aircraft 76-117 was lost, crashing about 100 miles southwest of St. Louis, its pilot ejecting safely. 76-118 was able to land. (USAF)

> between a large flock of birds, a thunder cell or a contact; I had to do that myself. Now we have multiple target track, etc.

The 48th FIS, like all ADC and ANG interceptor units, was required to maintain two fighters on alert at all times. According to Granrud:

> We would usually have two aircraft sitting in the alert barn at the end of the runway. We'd cock the jets and wait for the signal to go. When the call came, we would start the jet, align the INS, taxi and make a priority rolling take-off in as short a time as possible. We'd carry four AIM-9s and four AIM-7s, and once airborne, usually flying in prearranged corridors where we'd be cleared and climb unrestricted, we'd be passed from departure control to the air defense unit [ADU – ADC-speak for GCI]. They'd give us our target or intercept co-ordinates. For practice, which usually happened about twice a week, they'd give us CAP stations and then vectored targets in towards us. When a real alert came, as it often did when the Soviets flew large scale exercises, we'd be required to make sure they did not penetrate the ADIZ. During the daytime the intercepts were quite routine. We'd fly up to them and keep them away from the ADIZ. Sometimes they would wave and we would wave back. More often than not we'd fly most of our intercepts in October – the Soviets would fly down to Cuba for the winter! On the way there they would fly straight in as they were low on fuel, but once there, they would test our defenses and reaction times. We knew from their flight profile where they were going to go; sometimes low and up the East Coast, sometimes higher and along to the West. We'd shadow them all the way – one ADU would hand them off to another.

Vought ASM-135A Anti-Satellite Weapon

The Vought ASM-135A ASAT was a kludge of various components which made an air-launched, IR-guided "hittile" (meaning it had to actually hit the target satellite to destroy it, the ASAT carried no warhead). The first stage was that of a Boeing AGM-69 SRAM-A (Short Range Attack Missile – used by SAC bombers to suppress enemy SAMs on ingress). To this was bolted a variant of the Altair III rocket, upon which was mounted a small IR-guided "homing kinetic kill vehicle," designed to zero in on the heat source of an oncoming satellite and smash into it.

For a successful engagement, the ASAT had to be launched from an extremely high altitude (80,000ft) and high angle (60-65 degrees), exactly on the predicted track of the oncoming satellite. Prior to the satellite appearing over the horizon, the F-15 would be positioned in a holding pattern along this path by NORAD controllers, using their satellite tracking data of the target to ensure exact placement. On NORAD's command, the satellite interceptor pilot would head towards the target, accelerate to high Mach and then zoom upwards in a steep climb angle to launch the missile.

After numerous captive carry and zoom climb tests by two different 6512th Test Squadron F-15As, the first launch of the ASM-135A was made in January 1984 with the missile aimed at a pre-determined point in space. This was followed, over the course of the next year and a half, by three launches with the IR-seeker locked on to the IR-signature of a "celestial IR source" (more commonly known as a star). Finally, on September 13, 1985, F-15A 77-0084 was used for the first and only launch against an orbiting satellite, the Solwind P78-1. This 2,000lb, 11ft gamma-ray spectrometer satellite had been launched in February 1979 and by late 1985 had officially outlived its useful life, although it was still sending data from its circular polar orbit. Since Soviet reconnaissance, maritime surveillance and electronic intelligence (Elint) satellites were normally placed in polar orbits, Solwind P78-1 made a perfect target simulator.

The launch went flawlessly and 320 miles above the earth the speeding satellite – whistling along at 17,000mph – was impacted by the 11,000mph ASAT and the combined velocities smashed the Solwind satellite into smithereens. However, the celebrations were soon drowned out by the indignant outcry of the solar scientists still receiving and using the data from the satellite and by arms control activists. The latter soon convinced Congress that the test was in violation of the recently signed US–USSR ban against the testing of or use of weapons in space and Congress cut the funding to the program, the USAF officially terminating it in 1986.

ABOVE
Occasionally the FTU instructor pilots are deployed for their own training. Bringing this chapter full circle, 95th FS "Mr Bones" F-15C 78-505 takes off with two "bags of gas" and an ACMI pod from Elmendorf AFB, Alaska. This F-15C started as a 12th TFS jet that went to Tyndall when the 18th Wing drew down to 18PAA (primary assigned aircraft) squadrons in 1993. (USAF)

The first Northern Tier base to convert to the F-15 was McChord AFB, near Seattle, Washington, a Military Airlift Command Base. The FIS there was the 318th[8] and it officially completed its conversion to the F-15 on December 30, 1983. In addition to sitting air defense alert, the 318th maintained an alert detachment at Castle AFB, Merced, California, frequently using the host base's B-52 Stratofortresses as simulated "Bear" bombers on practice missions.

These two ADTAC units were also unique in the adoption of the anti-satellite (ASAT) role. Each squadron had three or four airframes modified to support carriage of the ASAT missile. This missile was a 17.8ft-long, 2,700lb two-stage IR-guided projectile hauled on the Eagle's centerline station. The modification to the F-15s included a battery (the Eagle otherwise never had a battery, relying on the JFS-mounted generator for internal electrical power when the engines were not running), an independent microprocessor, datalink for mid-course guidance to the missile, and separate wiring to launch the missile from the centerline pylon.

The second Northern Tier Eagle unit was the 5th FIS "Spittin' Kittens" stationed at Minot AFB, North Dakota, a SAC base. The 5th FIS's last '106 departed on April 5, 1985. About the time the "Spittin' Kittens" came "on board," both the US and USSR had begun to perfect the cruise missile in its air-, sea- and ground-launched versions. Most worrisome to ADTAC was the threat of Soviet bombers – now including supersonic Tu-22M "Backfires" – coming "over the Pole" crossing northern Canada and unleashing numbers of

AS-4 "Kitchen" nuclear-tipped air-launched cruise missiles against the northern US cities. Therefore, the "Kittens" trained hard against multiple, fast, small radar cross section (RCS) targets crossing the Canadian tundra, and practiced short-notice deployments to Canadian bases in order to meet the threat as far out as possible.

The amalgamation of ADC into TAC occurred on December 6, 1985 with the redesignation of ADTAC as the 1st Air Force, moving to Tyndall AFB, Florida, the traditional home of ADC interceptor training. There, the only other major flying component of the old ADC, the Air Defense Weapons Center (ADWC), had been training interceptor pilots on the Convair F-102 and F-106 for two decades when, on July 1, 1981 TAC redesignated it the 325th TTW and announced that it would be moving all F-15C pilot training to the new (for TAC) base. Back at the Luke "schoolhouse," the 58th TTW had become, on August 29, 1979, the 405th TTW and the 58th "flag" went to the new RTU for the newly arriving General Dynamics F-16 Fighting Falcon. Once the 325th TTW stood up, it began to receive F-15s from Luke as the 405th began to transfer F-15C training responsibilities to Tyndall.[9]

The 325th TTW (later 325th FW) was another historic fighter group from WWII, known then as the "Checkertail Clan" for its yellow and black checkerboards on the tails of its P-40Fs, P-47Ds and P-51B/C/Ds. During WWII the 325th consisted of the 317th, 318th and 319th Fighter Squadrons, and was involved in combat from Operation *Torch* until the Nazi surrender. After WWII the group was moved about the US West Coast as an interceptor unit flying Northrop P-61 Black Widow night fighters, radar-equipped F-82F Twin Mustangs, and F-94A Starfires until being inactivated in February 1952. It was resurrected in August 1955 as the 325th Fighter Group (Air Defense) at McChord AFB, Seattle, Washington, its three traditional squadrons flying the radar-equipped North American F-86D interceptor. However, as technology advanced, the group was broken up and eventually was disbanded as the squadrons became autonomous FISs. Only the 318th "Green Dragons" received the F-15.

The first F-15A (74-0103) arrived at Tyndall on December 7, 1983. The 2nd TFTS "Unicorns"[10] began converting from the F-106 Delta Dart the next month. At the same time the 1st TFTS "Fightin' Furies" was activated on January 1, 1984 and together these two squadrons took six months to achieve the operational standard to instruct F-15 students. The first Tyndall RTU class began that August. Meanwhile, the 95th Fighter Interceptor Training Squadron[11] (nicknamed "Mr Bones" after its dashing, top-hatted and monocled skull motif) gave up its ancient Lockheed T-33A Shooting Stars for Eagles beginning April 1, 1988, becoming a TFTS in the process.

Except for the 325th TTW, the former ADC units had a short lifespan in TAC. The 5th FIS was inactivated on July 1, 1988, after only three years flying the F-15. Its Eagles went to the 101st FIS of the 102nd Fighter Interceptor Group (FIG) located at Otis ANGB, on Cape Cod, as part of the Massachusetts Air National Guard (ANG). The mission of guarding America's Northern Tier was passed to the 119th FIG, flying the F-16A Block 15 Air Defense Fighter (ADF) variant from Fargo, North Dakota.

Similarly, the 318th was closed on Pearl Harbor Day (December 7) 1989 after less than six years as an Eagle unit. Its F-15As were transferred south to Portland, Oregon, to equip the 123rd FIS of the Oregon ANG's 142nd FIG, which assumed the alert commitment at McChord. The 48th FIS was the longest lived of all the former ADC units, lasting until September 30, 1991 when it was closed and its jets transferred to the 110th FS of the Missouri ANG's 131st FW at St. Louis' Lambert Field. On a rotational basis, F-16s also began to sit alert guarding the US's Eastern Seaboard from the former ADC alert facility at Langley AFB.

... AND THE GIUK GAP

The Greenland-Iceland-UK Gap (GIUK Gap) was a highway for Soviet LRA bombers and Soviet Navy maritime reconnaissance aircraft (MRA) from the earliest days of Castro's affiliation with the USSR. Ultra-long-ranged Tu-95/142[12] "Bears" would frequently depart air bases around Archangel and Murmansk and after rounding the North Cape (of Norway) head down through the GIUK Gap on their way into the North Atlantic to either monitor shipping and NATO naval formations, or to probe US air defenses during their rotational flights to Cuba. Therefore, it was critical to demonstrate to the Soviets that approaching this strategic passage

HH
AF 77 077
HH
AF 77 114
HH
AF 77 074

ABOVE
The Keflavik alert commitment was last filled by Air National Guard jets such as these Hawaii ANG F-15As Aircraft 77-074 and -077 came from the 49th TFW at Holloman, while 77-114 is a former 122nd FS Louisiana Guard jet. All are sporting fresh Mod Eagle paint jobs as they cross-country over the "Mainland." Leaving their tropical paradise for the arctic conditions of Keflavik must have been tough for the "HANGmen!" (Rob Tabor via Steve Davies)

they were sure to be intercepted, monitored and shadowed throughout their transit flights. The best opportunity to do this was when they flew through the relatively narrow gap between Greenland and the UK. Conveniently placed in the middle of this gap was the small NATO nation of Iceland and its modern air base at Keflavik had been the home of the 57th FIS[13] since November 1954.

Iceland had joined NATO in 1949, but lacked a military of its own and initially refused to allow foreign military units on its territory. However, the Soviet's development of long range nuclear bombers prompted a policy change and on May 5, 1951 an agreement was signed that permitted NATO to base aircraft there to defend the small island nation. Things changed again 11 years later when Cuba became a Communist country and the USSR began conducting long-range flights through the North Atlantic to its new ally.

To meet this challenge – and the threat it represented to NATO North Atlantic sea lanes in general, and the US Eastern Seaboard in particular – the 57th FIS upgraded to the F-102 in 1962, the F-4C in 1973 and the F-4E in 1978. By the mid-1980s the Soviets had established a considerable submarine-launched ballistic missile (SLBM) capability to complement their LRA and ICBM forces. Most of the Soviets' SLBM submarines (called "boomers" or "missile boats" in the submarine service) were based at Archangel and Murmansk and had patrol/launch stations in the far north White Sea. It was the job of the USN nuclear-powered attack submarines to locate these, shadow them and be prepared to torpedo them if World War Three began. Since the US submarines had to pass through the GIUK Gap to get to their charges, the Soviet navy began to send increasing numbers of "Bear-Fs" to seed it with sonar-buoys in order to discover and track the attack boats as they headed north to hunt the boomers.

Thus, in November 1985, the 57th FIS "Black Knights" received their 12 F-15C/Ds (having never operated the earlier A/B-models). Keflavik's Eagles were different, however, in that they came with CFTs mounted. While not technically a permanent fixture to the airframe, the 9,800 extra pounds of fuel in each CFT allowed the "Knights" to intercept the "Bears" much further out and shadow them for a much longer duration than ever before, and thus the CFTs were a standard feature of the Iceland jets. Because the CFT design was so well integrated into the airframe of the F-15C, it added only a little cruise drag and had no adverse center of gravity problems (as long as the CFTs' internal fuel tanks all functioned properly). Normally the 57th flew its intercepts with CFTs and no external tanks. Because of the added fuselage girth imparted by strapping the CFTs to the Eagles' sides, these jets were known in the community as "the wide bodies."

Between 1962 and 1991 the "Black Knights" intercepted over 3,000 Soviet LRA and MRA aircraft. During the heyday of the Cold War (1985–86), the Icelandic Eagles logged a total of 340 intercepts. Assisted by knowledge from NATO (primarily Norwegian and RAF) air defense centers "up track" that "Bears" were headed down towards the GIUK Gap, and by the Boeing E-3A AWACS aircraft from the 552nd Airborne Warning and Control Wing,[14] the "Black Knights" generally had fair warning that the Soviet bombers were headed their way. Upon notification that tracks were inbound, the E-3 would take off first and the F-15 crews were placed on a heightened readiness, allowing them to get into their cumbersome anti-exposure "poopy suits." With notification that "the 'Bears' should be in range by now," two F-15s[15] would be launched to meet them well prior to their approach to the Iceland Military ADIZ (MADIZ), followed by a KC-135 to keep the Eagles topped off with fuel and maintain an ability to divert to alternate bases.

LtCol Tim "Sweet Lou" Kline[16] was a member of the "Black Knights" from January 1987 through February the next year and flew more than a dozen intercepts against the "Bears" during that time. He recalled:

> They were long intercepts. Usually we'd blast off – AWACS would already be airborne – and they'd give you an INS point to run out to and set up a CAP and some coordinates where they expected the "Bear" to come down to. Then they would act as a radio relay back to Keflavik. These points could be 450 miles away from Kef.
>
> And we'd be sitting there waiting, looking down at the water – the icebergs in the cold water – and getting our gas from the tanker while we waited, hoping our refueling equipment worked because we were far away from Keflavik. Sometimes we could be out there six hours. If we got launched and went out and the "Bears" didn't come down, we'd call it a "heave."

Early in the "game" the "Bears" were very predictable targets. They normally flew in the mid-20s (24–27,000ft altitude) and at a sedate, economical cruising speed, saving their fuel for probing the US ADIZes, or the low altitude work of dropping sono-buoys. The four sets of large-diameter, contrarotating propellers on the massive Kuznetsov NK-12MV turboprop engines made huge radar reflectors[17] and it was not uncommon to "get a hit" (a raw radar return) in excess of 80nm.

Kline continued:

> But when they did show up, they'd still be at altitude. Oftentimes we would simply go "pure pursuit" on the raw return because to obtain a lock on would not only give away our presence but also allow the "Bear's" EWO (electronic warfare operator) to begin tuning in his EW gear and start "dueling electrons" with the APG-63. It was important to not let them know what range we could actually get a lock on at and other information that would prove valuable intelligence to them. So usually, we'd just stay in search LRS. It was easy to estimate the altitude of the "Bear" by noting what bar in the scan pattern the hit "lit up on" and using the "60 to 1 rule" [1 degree equalling 1nm – or 6,000ft – at 60nm] doing a simple math problem involving F-15 altitude, degrees up or down look angle, and range to the target to calculate the altitude of the "Bear." Once we knew that, it was a simple task to keep the radar search volume centered over the target altitude and continuing to highlight it as we approached within visual range.
>
> Once the "Bear" was picked up visually it was a simple "conversion turn" to swing up alongside, being careful to avoid the fire cone of the

> twin 23mm cannon in the tail turret. We'd have the wingman stay back in a cover position, out of range of those guns, but he would get locked up by the tailgunner's radar. The flight lead would get up on the "Bear's" wing and pull out the old Nikon camera and get the pictures – and copy down the tail number – for Intel. Then when they got into their dropping area, they'd ramp down to about 300–500ft altitude and slow down to about 230 knots to start dropping the sonobuoys and we would "call the drops" so AWACS could plot their locations for Intel. When they were done they would turn around and go back northeast to Russia.
>
> Sometimes things got real sporty. Lots of times in bad weather we'd have to inch up on the guy from behind very slowly until we could see him. If they were low, they seemed to enjoy making turns into you, trying to scrape you off into the water. The F-15 is not real responsive slow and heavy like that so sometimes we'd have to reposition. In doing so, if we lost sight of the guy, we'd have the wingman come up on the wing while we dropped back, reacquired the guy on radar and assumed the cover position.

At night the "Bear-F" would sometimes use its powerful spotlight, mounted on the empennage, to disorient an intercepting Eagle pilot. One "Black Knight" took great umbrage at having such a powerful light shined into his eyes while in close formation and retaliated. Racing out ahead of the "Bear," he turned around, pointing at the bomber nose-to-nose, and lowered his gear, which shined his landing light in the faces of the "Bear" pilots as the two aircraft closed at a combined speed of over 500 knots in the pitch darkness. It had to look like a locomotive approaching at phenomenal speed! While the Eagle Driver was chastised severely for his tactic (some say "antic"), the "Bears" never did that again!

On another occasion, at the very height of the Cold War tensions, the creative minds at Keflavik[18] decided to give the Russian Intel officers something new to ponder. They had the squadron's mechanics fabricate a fictitious EW pod by taking a normal MXU-648/A baggage pod and affixing various disused UHF, automobile, and other sorts of antennae to its surface at odd angles. The pod was then mounted in its usual position beneath one of the underwing pylons of an alert jet and soon enough the crew scrambled to meet an incoming "Bear." Once the intercept was complete, the pilot made certain to roll out alongside the "Bear" with the pod fully visible to the Russian crewmen who gathered in the rear observation blister for a look at their interceptor. Immediately upon seeing the "new EW pod" a battery of cameras was pulled out and film was repeatedly exposed. Later, back at the bar at Kef, the "Black Knights" shared the laugh, wondering just how much work and time some Soviet AF intelligence officer would waste in his effort to discern the purpose and frequency bands used by this new USAF jamming pod.

Occasionally other humorous exchanges took place. For instance, more than once the liberty-loving young Eagle Drivers of the "Black Knights" would attempt to share one of the many joys of our Western freedoms by spreading a *Playboy* nude centerfold across the expansive side of the Eagle's long bubble canopy, for the appreciation of the more cloistered and deprived fellow aviators. Usually this would elicit grins from the small crowd gathered in the glass blister. The "Bear," of course, was air-to-air refuelable using the probe-and-drogue system similar to that of the RAF and USN. The "Bear's" probe was encased in a long cylindrical tube extending from atop the nose (from just forward of the base of the aircraft's windscreen) and would be run out to plug into the drogue basket. In at least one instance, when the "Bear" pilots saw the *Playboy* nude spread in full view for them, they responded by running the probe in and out, and in and out of its protective sleeve.

But the "fall of the wall" in Berlin signaled the end of the Cold War and after 1991 "Bears" no longer approached the Iceland MADIZ.[19] The "Black Knights" maintained their vigil for another three years before drawing down to four F-15Cs in 1994. On March 1 the next year the squadron passed into the history books, the alert commitment being passed to rotations of various active duty and ANG F-15 units. Over the past ten years even this has proven unnecessary and the USAF alert detachment at NAS Keflavik has closed.

005

08

AIR NATIONAL GUARD EAGLES

FIRST DELIVERIES

The 122nd TFS, 159th Tactical Fighter Group (TFG), of the Louisiana Air National Guard became the first Guard unit to equip with F-15s, in August 1985, replacing its F-4C Phantom IIs with 18 F-15As and two F-15Bs transferred from the 405th TTW. In a ceremony held to mark the event, MajGen Ansel Stroud, adjutant general of the Louisiana ANG, received a giant "key" to the Group's first Eagle from Denver Clark, McAir's vice-president of marketing at the time.[1] Delivery of the Eagle to the 122nd TFS was followed in October 1986 by the acquisition of 24 Eagles by the 128th TFS, 116th TFW, Dobbins AFB, Georgia – home of the Georgia ANG.

The Louisiana ANG – or as it was known at the time, the "Coonass Militia" – was as much of a proving ground for the concept of giving the F-15 to "part-time" aviators as anything else. There was much muttering in the Active Duty (AD) world that the jet would not be effectively employed by a band of "weekend warriors" for whom maintaining currency would be an issue. As it was, these doubters were proved to be wrong, and the squadron led the way with its Eagles, not only proving itself a worthy recipient of the jet, but also innovating as it went along. For a start, its base at NAS New Orleans gave it access to an unprecedented training area over the Gulf of Mexico that was unrestricted from the surface to 50,000ft, and which took less than 10 minutes to reach from the moment of brake release. It used its considerable experience in the Phantom to quickly get to grips with actually flying the jet, and was then able to learn the new tactics for the Eagle. In a move that would later be adopted by the Air Force for all its Eagle units, the squadron also self-funded 8mm video recorders to film its VSDs and HUDs for debriefing purposes.

There were some problems initially, but most came about as a result of the different maintenance standards that the ANG upholds when compared to the AD Air Force.[2] The old 1973-build A/B-model jets that the "Coonass Militia" received were in bad shape, and so the unit had to strip them down and conduct remedial work to ensure they would operate with maximum reliability. An even more time-consuming problem was related to fuel. The jet fuel available at NAS New Orleans was of the navy's JP-5 type, whereas their Eagles had been fed on JP-4 up until now. The change of gas led to corrosion of the fuel tank seals, and the squadron had to have its entire fleet of Eagles undergo fuel tank resealing at enormous expense and consumption of maintenance man-hours.[3] In 1991 all of the 122nd TFS's 1973 jets were replaced by 1977 jets from the 49th FW at Holloman AFB, which were in turn replaced by MSIP F-15As in 1993; the same year the squadron adopted the more politically correct "Bayou Militia" moniker.

OPPOSITE
Peering back to check his wingman, this "HANGman" sets course for Hawaii. The expanse of airspace available around the island – just avoiding the airliner corridors east and west of Honolulu International Airport – is obvious in this view. It is a primary reason why the HI ANG will be the first Guard unit to boast the F-22 Raptor. (USAF)

The next Guard Unit to receive the Eagle was also the first to lose it. Georgia ANG's 128th TFS, 116th TFW was the proud recipient of its first F-15 (74-128) on March 28, 1986. This F-15A, and many others, came from the 405th TTW, which was closing as the Eagle RTU moved to Tyndall. Others were from the 33rd TFW at Eglin and the new 325th TTW at Tyndall as their A/B-models were replaced by C/D-model jets released from the 36th TFW at Bitburg AB, West Germany, when that wing transitioned to the MSIP F-15C. The 116th TFW operated the Eagle out of Dobbins ANGB, near Atlanta, for nearly a decade, but when its last F-15 departed on August 30, 1995 the end of an era descended upon what had traditionally been a fighter wing, and the 128th Bomber Squadron stood up to take delivery of its first B-1B.

It was an early deployment to Hawaii by Georgia's Eagles that had helped pave the way for the introduction of the jet to the Hawaii ANG (HI ANG, or more commonly called "the HANG"). The 199th TFS initially received Eagles from the 43rd TFS at Elmendorf AFB, Alaska, to convert to the F-15 in March 1987. Settled nicely on the paradise island, the HANG saw its older F-15s replaced by 26 newer ex-49th TFW MSIP-A Eagles in 1992 and has since been instrumental in the integration of the Fighter Data Link and Night Vision Goggles (NVGs) across Guard Eagle units.

LtCol Matt "Boz" Beals, an Operation *Desert Storm* (ODS) veteran F-15 IP with all of his 3,400 hours of operational flying in the Eagle and 154th Wing[4] Chief of Stan/Eval, is one of the seven F-15 "full-time Guardsmen"[5] in the unit. As he explains:

> The Guard is built on the traditional militiaman concept where citizen-soldiers are called for duty defending our country. As a full-time Guardsman, my primary job is to facilitate the part-timers' training. As a full-timer I look at my job as being part of the infrastructure of the squadron. We full-timers are the nuts and bolts, the carpenters and electricians; we keep the squadron going so that the part-timer can come in here and effectively use their time, because there's only a certain amount of duty time available to the part-timer.

LEFT
Two F-15Cs of the 110th FS, 131st FW, Missouri ANG, pull into the vertical and release flares. The ALE-45 CMDs can accommodate MJU-10 and MJU-7 flares, the latter of which is larger and burns brighter (as here). (Steve Davies: www.fjphotography.com)

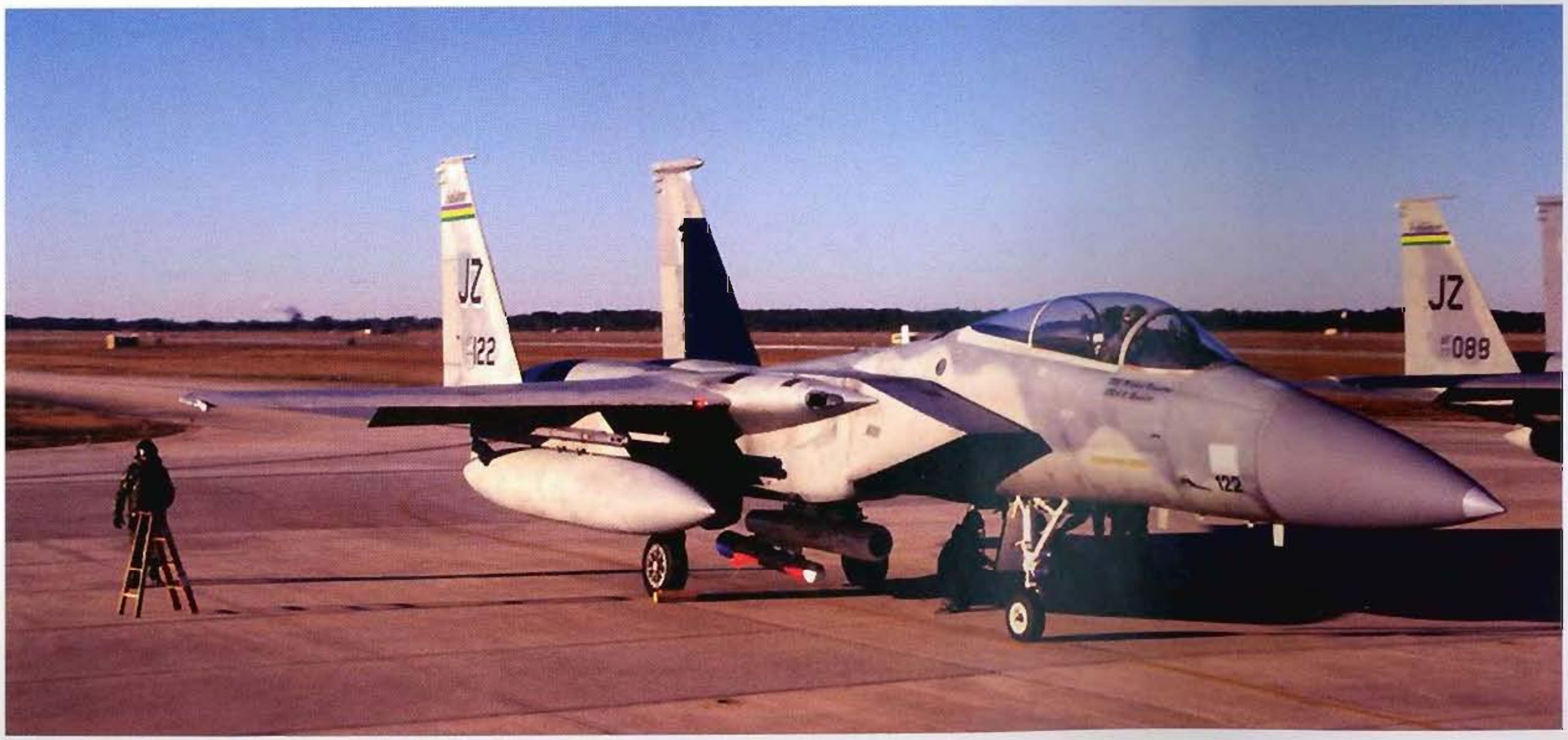
> A typical week would be for us full-timers to fly three times in a week, depending on your qualifications and availability. We have two 'goes' launches each day, typically an 07:30 briefing and a noon brief. We schedule that way to help the part-timers and their work schedules. They may be able to come in and fly in the morning and go to their civilian jobs in the afternoon or work at their civilian jobs in the morning and come in and fly in the afternoon. It's also based on operating out of a very busy international airport in that there are some flying windows in the airliners' schedules of arrivals and departures that are good for us. Airspace is not an issue. We get as much airspace as we need whenever we want. It was probably a huge player in the decision to base the F-22 here in the future.
>
> During the week the 199th FS will normally fly eight morning sorties followed by four in the afternoon, or six and six. For night flying the unit flies four in the afternoon and eight that night (or six turn six).

The unit is very big on night flying and pioneered the use of NVGs. As Beals explained:

> Most fighter units just do the minimum when it comes to night flying. But because of how much we pride our unit in night flying, having done the initial DT&E for Night Vision Goggles, we take it very seriously. We will schedule at least two weeks of night flying every other month. That way the part-timer will never go past the 90/120 [90 days in 120] day currency requirements for NVG and night flying. Again, it is built around the part-timer.

Usually the first weekend every month is a "drill weekend" where the whole unit is on base. The flying is done on Saturday, usually an

BELOW
The Louisiana ANG's MSIP F-15A Eagles carry "JZ" tailcodes in reference to the jazz music that is synonymous with New Orleans. The lack of teardrop ICS fairings above and below the nose is one of the few external differences that helps distinguish the MSIP A-model from the MSIP C-model. This Eagle is configured as a target tow for gunnery practice. (Gary Klett via Steve Davies)



eight-turn-eight-turn-eight (24 sorties), or a "quad-eight" (32 sorties) surge when there's an emphasis on intense, short duration (0.7 hour) BFM training. During these days, the part-timers typically "double turn" to get in two sorties in one day. Sunday is reserved for ground school, such as weapons academics, and ancillary training such as 9mm Beretta hand-gun qualification and other USAF and ANG requirements. Through the effective and efficient management of programs given by the full-time Guardsmen, the worry about maintaining currency and the cutting edge needed for combat has proven unfounded since the average ANG Eagle Driver flies between six and twelve sorties per month, and since they are in a Guard unit, they stay year-on-year. The average Eagle time for the 199th FS pilot is over 1,700 hours.

These highly experienced Eagle Drivers fly some of the oldest, yet some of the most advanced F-15As in the ANG inventory. In addition to being MSIP/AIM-120 upgraded, these jets use Fighter Data Link (FDL; Link 16), carry AIM-9X and have BOL IR countermeasures mounted to their underwing pylons. Most appreciated by the Hawaiian Eagle Drivers is the fact that their lighter weight F-15As are now powered by the F100-PW-220 engine making them "awesome BFM machines." Slated to receive Kadena's F-15Cs before transitioning to the F-22 Raptor, neither the pilots nor the 199th's maintainers are excited about trading in their immaculately cared for and extraordinarily capable MSIP-As for the well-worn F-15Cs of the 18th Wing.

Flying "more vanilla" F-15As and Bs, three ANG units took over the former ADC interception role: the Massachusetts ANG's 101st FS, 102nd FW on the East Coast; the Oregon ANG's 123rd FS, 142nd FW on the West Coast; and the Florida ANG's 159th FS, 125th FW in the southeast, guarding against any incursions from communist Cuba.

The 101st FS received its first F-15A in September 1987 and was the first ANG air defense unit to receive the Eagle. 76-0058 was the former 58th TFS "Gorillas" flagship and arrived from the 5th FIS. By midway through the next year the unit had retired its old F-106s and was up to its authorized strength of 18PAA. It maintained alert detachments at both Otis ANGB on Cape Cod, and at Loring AFB, Maine, taking over the air defense alert responsibility for northeast America from the 5th FIS and, later, the 49th FW.

The 123rd FS received its first Eagle, an F-15B (76-0139) from the 318th FIS in October 1989, and took responsibility for protecting the west coast border from northern California all the way up to Canada. To make this possible, the "Red Hawks" operate an alert detachment at McChord AFB, Washington.

Finally, the 159th FS's first Eagle (F-15B 76-0125) arrived in October 1995, thus replacing the F-16ADF, whose radar and weapons reach was seen as inferior to the Eagle's, making the Eagle a better platform with which to patrol the southeastern quadrant of the USA. Alert detachments at Tyndall AFB and NAS Key West facilitated execution of this mission.

Transitioned to the F-15 from the F-16A/B in 1995, Detachment 1 of the 125th FW is responsible for the maintenance of a NORAD air defense alert site at Homestead ARB (Air Reserve Base); providing armed F-15s to intercept, identify and, if necessary, destroy unknown aircraft which penetrate sovereign US airspace. In the past, this threat has included Soviet "Bear" bombers, Cuban fighters, and narcotics traffickers.

These units have kept pace with the AD Eagle operators but sometimes for non-traditional operations. One such example was the Massachusetts ANG's adoption and integration of NVGs in 1998 to aid the visual identification at night of drug trafficking light aircraft operating lights-out. This was something of a challenge, not only because of the small size of their targets, but also because the Eagle's cockpit was not NVG-compatible, and they were therefore required to operate without cockpit and external lighting of their own. The traditional role of these three units has evolved steadily since the Iron Curtain came down and "Bear" intercepts became less and less common.

Up until 1998 Guard Eagle pilots were trained by the FTU at Tyndall, but when the 114th FS, 173rd FW (Oregon ANG's second fighter wing) replaced its own F-16ADFs in 1998, its Klamath Falls base became the new home of Eagle students destined for the Guard; moreover, it will become the only Eagle FTU and will take responsibility for AD Eagle students once the F-22A Raptor takes over at Tyndall. In 1999 the Florida ANG assigned instructors to Tyndall's 325th TFW in a move that freed up AD pilots assigned as IPs at the B-course (basic course at the FTU) to return to their units, thus alleviating a temporary shortfall in Eagle Driver numbers.

THE MOGAR

The Missouri ANG came together in 1923 initially as the 110th Observation Squadron flying JN-4 "Jennys," but by the 1940s it had been redesignated the 110th Tactical Reconnaissance Squadron and was seeing duty flying P-39, P-40 and P-51 fighters in Australia, New Guinea, the Philippines and Japan. A short stint flying the B-26 bomber in the 1950s was followed quickly by the acquisition of T-33, F-80 and F-84 jets, thus beginning the Squadron's association with jet fighters. It was following the delivery of F-100 fighters to its Lambert Field, St. Louis Airport ramp that the Squadron adopted the moniker "Lindbergh's Own" in the late 1960s, and when the venerable Super Sabre was superseded by "home grown" McDonnell Douglas F-4D Phantom IIs in the 1970s the Squadron was just one step away from flying the world's greatest fighter.

Hack, or Hero?

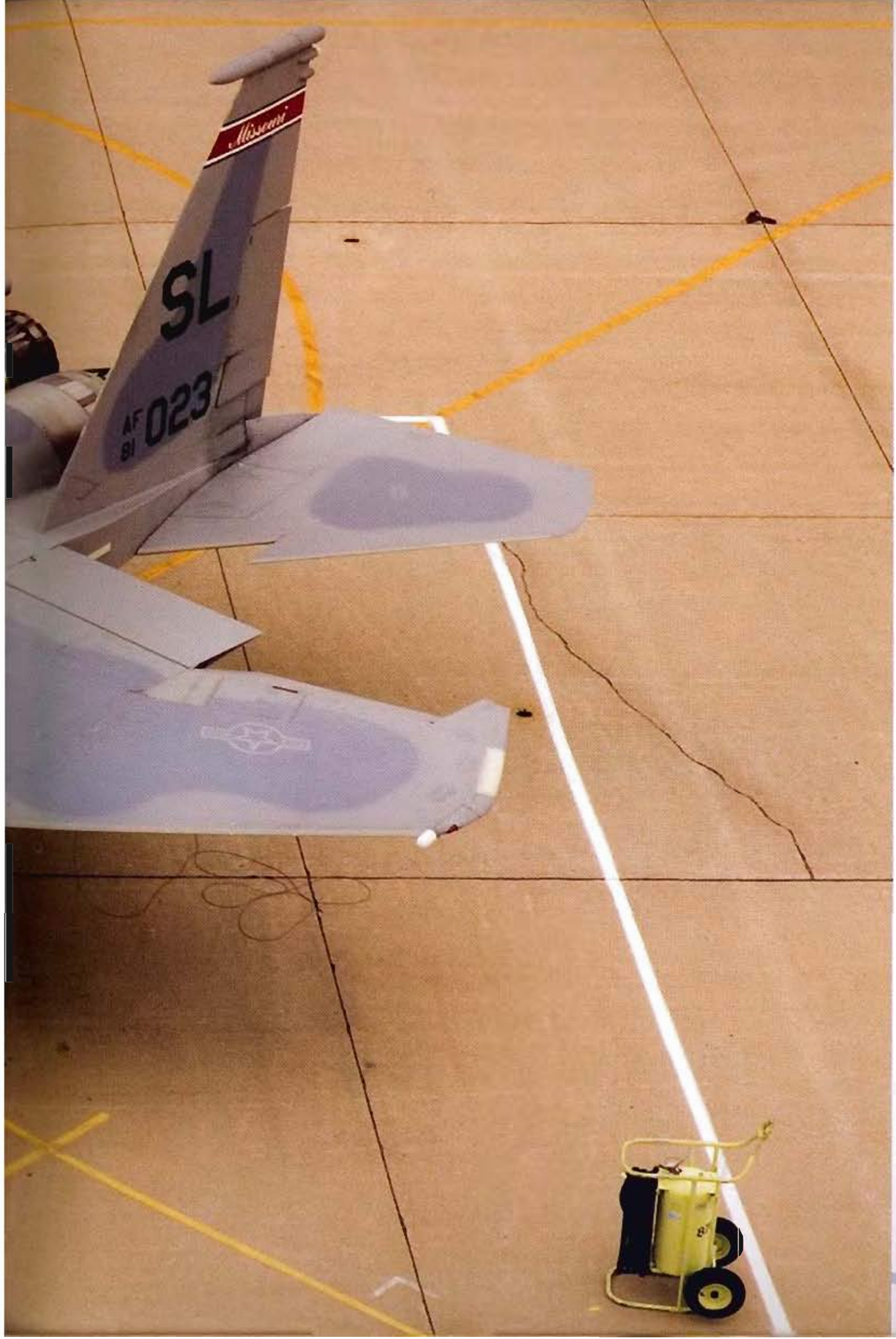
"There's a fine line between Hack and Hero," says LtCol Moss "MOS" Mohr, a MOGAR Eagle driver, in regards to two near-identical incidents in the Eagle that could have turned out very differently. For the first, which occurred at Nellis AFB in July 1996 and resulted in Mohr being awarded the AETC Aircrew Safety Award of Distinction that year: "The background was that two months prior, Capt Fontaine from Langley AFB had punched out of an Eagle at Nellis for an engine problem on take-off. Unfortunately, his was an A/B problem that he misdiagnosed. He pulled the wrong engine, ejected low altitude, landed pretty much in the fireball, and he was hurt pretty bad. In addition, that summer an F-16 had jettisoned an ACMI pod over Pensacola following an engine problem and killed someone when it landed in their home. Both these incidents were fresh in my mind. The fact that I was the air-to-air mission commander for this *Red Flag* mission also played a significant role in my decision matrix. With these facts in my head, Murphy's Law and the standard links in the chain came into play that day," he recalls.

"On take-off I experienced a left A/B anomaly, but I decided to press on with the take-off since I knew despite the 107°F air temperature and the two-bag configuration, the jet could easily take-off with just one A/B... and after all, I was the mission commander and mission commander sorties are few and far between. However, when the 'good' engine – the right engine – decided to drop to 73 percent well past abort speed, I now had a problem. My immediate thought was to put the nose down and get as much airspeed as possible by the end of the runway so I could maximize the wind available to open my 'chute when I ejected. When I actually got to the end of the runway though, I realized that I was faster than expected and I might be able to fly this thing away. As I gently pulled back on the stick, the jet slowly lifted into the air with significant AoA buffet. Basically, I was using ground effect to stay airborne. As I crossed the runway departure end, I reached down to punch the tanks and noticed the line of cars on Nellis Boulevard heading to lunch, and the housing area on the other side of the road that I was fast approaching. Remembering the F-16 pod jettison incident, I figured that I didn't want to napalm all these people and be on the five o'clock news, so I decided to keep the tanks as long as I remained level to climbing.

"My next thought was that you've always got to sound good on the radio despite the seat cushion up your ass. I made a call on the Aux radio to my No. 2 man, 'CYLON TWO, I'm going to be a little bit low and slow at the end of the runway so don't hit me.' Then I made a call on the main radio to departure control, 'Departure, CYLON ONE. I'm having a slight double engine problem and I'll be going downtown. I'll get back to you in a minute.' With that I proceeded to fly straight toward downtown Vegas with about a 1 degree nose-high climb. After removing the seat cushion from my ass and getting some altitude I eventually headed back over the desert and started to dump gas, but as Murphy would have it a piece of tank foam had clogged the dump mast. I ended up having to burn down gas from the two bag configuration while my right engine surged from idle to MIL the whole time.

"Being bored during the ensuing minutes, I tried to direct the air war from the airport pattern, but that didn't go over too well with the alternate mission commander. Oh well! Anyway, after reducing fuel I landed from a straight in, but the right engine basically stuck in MIL power during the landing roll. I shut off the engine and rolled out uneventfully. Like I said, there is a fine line between Hack and Hero... just a hair's difference between being the goat and winning AF and AETC Safety Awards."

22
10023



The 110th FS, 131st FW, Missouri Air National Guard (ANG) – or MOGAR – received its first F-15A (76-0030) in May 1991, and its final F-4E left in September the same year. Since then, the Squadron has become the only ANG Eagle unit to operate the F-15C, which it swapped for its old Eagles in 2004. The opportunity to get the newer Eagles followed a meeting at which representatives from each Eagle Guard unit were allowed to select which improvements from a list of those available they wanted. Included on the list was the option of one squadron receiving F-15Cs, and for others the offer of re-engineered F100 motors. Rumor has it that while the other units debated about which modifications to purchase, the MOGAR snuck in under the radar and put its name next to the new Eagles.

The 159th FS from Florida was the first of the remaining six squadrons to receive the PW-220E, with all of the other Guard units set to follow suit in the future.

To the outsider, the MOGAR is as close as you can get to a super squadron: it is home to the most experienced Eagle pilots and maintainers in the world. At one point in the late 1990s there were no fewer than 13 Weapons School graduates (including one Reisener winner for the best graduate) on the Squadron, and the average number of fighter hours for pilots on the Squadron currently stands at 2,500. There are three MiG killers on the Squadron and the average experience of its maintenance troops is 17 years.

The Squadron, still based at Lambert Field, used to look out across the airfield at the famous McAir factory with its massive, illuminated "McDonnell Douglas" logo above, but times are changing and Boeing has now taken the sign down and has plans to demolish the old building, and the MOGAR is enjoying what time it has left until its Eagles are gone and the unit formally transfers to the B-2 Spirit at Whiteman AFB. Until then, the Squadron will continue to fly five days per week, usually at a rate of eight four-ships of Eagles each day. Like the "Coonass Militia," the pilots and maintainers at the MOGAR have done much to rid the Guard of its reputation

LEFT
Commander of the 110th FS, LtCol Mike "Father" Flanagan's Eagle rests on the ramp at Lambert Field. The MOGAR is one of the few units that sports nose art on its jets: in this case a bald eagle with American and PoW flags draped from the tip of each wing. (Steve Davies: www.fjphotography.com)

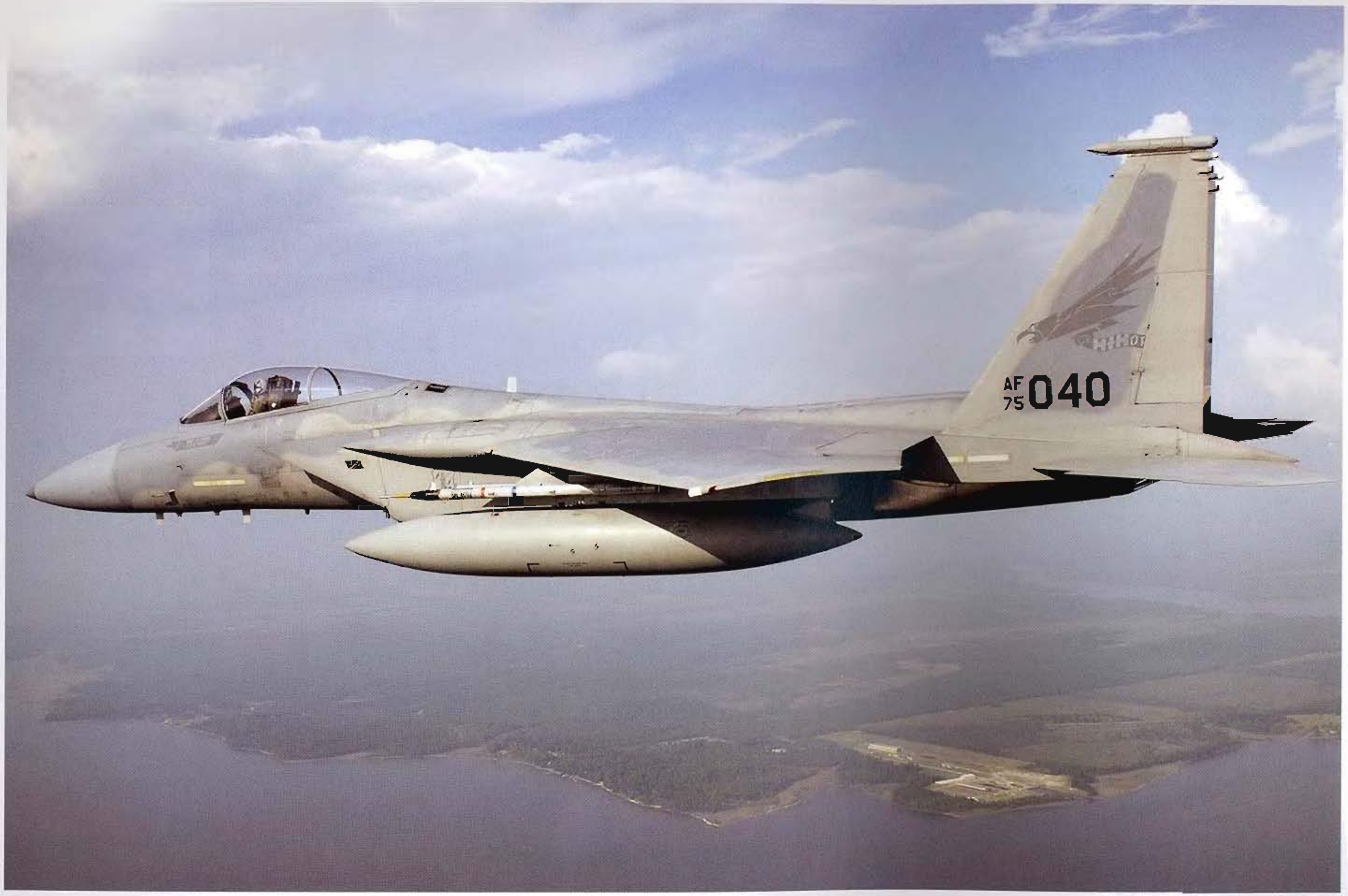
as "weekend warriors" and "a flying club," and have become a well-recognized center of Eagle excellence. Typically, they amass approximately 2,500 sorties each year, ranging from continuation and combat sorties flown while on deployments, to 1 v 1 dogfights all the way to 40 v 40 Composite Force war simulations.

BELOW
F-15As from the Otis ANG's 101st FS, 102nd FW fly CAP over New York during Operation *Noble Eagle*. The missions involved were long and tedious, but they were essential to ensure that any planned follow-up to the atrocious September 11 attacks was foiled. (USAF)

OPERATION *NOBLE EAGLE*

Since 1994, ANG Eagle units have increasingly left their home bases for temporary deployments to the world's hot spots. While the HANG's Eagles have always played the vital role of deploying to Kadena AB, Japan to replace either of the 18th Fighter Wing's two AD Eagle squadrons when deployed away from Japan, ANG units had until this time traditionally been associated with CONUS – Continental US – homeland security missions.

MA
101FS
MA
102FW



ABOVE
Although every ANG unit has been issued with tailcodes, the 123rd FS of Oregon's ANG is one of only two ANG Eagle units not to use them. Instead, the unit retains its decades-old red hawk logo. The other is the Florida ANG, which features a lightning bolt painted diagonally across the height of each fin. (USAF)

On September 11, 2001, the 101st FS sprang into action just minutes after the terrorist attacks on the World Trade Center in New York City. The Squadron began flying round-the-clock combat air patrol (CAP) missions immediately thereafter.[6] Eagle

ABOVE
158th FS, 128th FW F-15As sit quietly at dawn as a maintainer prepares for the rush of the day ahead. Competition among the Guard Eagle units is tough, but many concede that being hired by the 158th FS is just about as good as life for an Eagle Driver can get (USAF)

squadrons – both AD and ANG – began to cycle into the Operation *Noble Eagle* (ONE) alert schedule and were tasked to fly armed CAPs over key US cities in order to fend off further airborne attacks. In coordination with ground-based radars and AWACS platforms, they routinely flew nine-hour sorties while carrying a mixed load of AIM-9, AIM-7 and AIM-120 AAMs. The rules of engagement in the event that an aircraft was suspected of falling victim to hijack, or deviating from air traffic control assigned vectors, are comprehensive. In the first instance, the suspect aircraft will be intercepted and visual and radio communication is made with the errant aircraft's crew. In the event that this contact fails to elicit the appropriate response, the Eagle pilot will fly in front of the target and release flares to grab the attention of those on the flight deck. If a change of course is not made following this, the F-15 will fire warning shots from its M61A1. The final recourse, undertaken as a last resort, is to launch a single AIM-9 Sidewinder

Air National Guard F-15 Eagle Units and BRAC 2005

- **101st FS, 102nd FW, Massachusetts ANG, Otis ANGB**
  In BRAC 2005, the DoD recommended closing Otis ANGB. The 102nd Fighter Wing's F-15s would be distributed to the 125th FW, Jacksonville, FL (three aircraft) and 177th FW (currently an F-16 unit), Atlantic City, NJ (12 aircraft). However, the unit itself is on record as stating that its jets will go to the 104th FW (currently an A-10 unit), at Barnes Field, Springfield, MA, sometime around mid-2007.
- **110th FS, 131st FW, Missouri ANG, Lambert-St. Louis Airport**
  The MOGAR will eventually transition to the B-2 Spirit "Stealth Bomber" at Whiteman AFB, MO. The 110th FS's 15 Eagles are planned to go to the 57th FW, Nellis AFB, NV (nine aircraft), to become aggressors and to the 177th FW (currently an F-16 unit), Atlantic City, NJ (six aircraft).
- **114th FS, 173rd FW, Oregon ANG, Klamath Falls**
  Remains the ANG F-15 FTU and will begin training AD F-15 pilots as Tyndall AFB completes the transition to becoming the F-22 Raptor FTU.
- **122nd FS, 159th FW, Louisiana ANG, JRB New Orleans**
  To experience some growth – nine F-15As from Portland's 123rd FS – and consolidation: "The New Orleans ANG unit has above average military value for reserve component bases, and realigning aircraft from Portland would create another optimum-sized fighter squadron at New Orleans. By relocating the geographically separated ANG squadron into New Orleans, the Air Force would best utilize available facilities on the installation while reducing the cost to the government to lease facilities in the community."[7]
- **123rd FS, 142nd FW, Oregon ANG, Portland International Airport**
  Of the unit's 15PAA, nine F-15s are to go to the 122nd FS at New Orleans and six to the 177th FW (currently an F-16 unit), Atlantic City, NJ.
- **158th FS, 125th FW, Florida ANG, Jacksonville International Airport**
  Slated to receive six 366th FW F-15Cs as that unit distributes its 390th FS Eagles to become an all F-15E wing.
- **199th FS, 154th FW, Hawaii ANG, Hickam AFB, HI**
  To become the first ANG F-22 Raptor unit. In a reversal of policy, the jets will be "HH"-coded tails flown by an Active Duty associate squadron as well as the "owning" ANG unit.

at one of the aircraft's engines. Assuming that the target aircraft is multi-engined, successive launches will be made at the remaining motors if necessary.

Given the exceptional condition that the Guard maintains its jets in, and the huge amount of experience that it boasts, the most impressive thing about Guard Eagle squadrons is that even though they offer only 40 percent of the airpower that an AD F-15 squadron can, they deliver it at only 15 percent of the AD unit's total cost. To be fair though, this may be a somewhat misleading figure in that the individual state picks up the tab for the remaining costs of operating the unit.

812
22-8812

09

FOREIGN MILITARY SALES EAGLES

PEACE FOX F-15A/B/C/D

Israel became the first foreign military sales (FMS) customer to purchase the F-15 when it bought 25 A-model Eagles in 1975. The purchase was driven not only by the need to obtain new cutting edge technology, but also because Israel had fought the Six Day War in 1967, the War of Attrition with Syria and Egypt until 1970, and the Yom Kippur War in 1973, losing almost 200 aircraft[1] in the process.

A number of choices for a new interceptor and air superiority fighter were on offer when General Beni Paled, the Israeli Air Force (IAF) Chief of Staff, made the decision to replace these attrited airframes and find a successor to the IAF's fleet of F-4 Phantoms.

Iran, just one of Israel's many potential enemies, had purchased the F-14A Tomcat which had a similar price tag to the F-15, but offered superior long-range interception capabilities and better endurance. The Tomcat's radar (AWG-9) and weapons (AIM-54 Phoenix) had been designed to work cooperatively with the E-2C Hawkeye's AWACS radar and data link system, of which Israel was due to acquire four. The F-16A was more nimble than the F-15, but less able to loiter due to fuel constraints, and its APG-65 radar lacked the long-range detection capability of the APG-63. In truth, the IAF wanted to mix and match a combination of fighters: to buy either the F-15 or F-14 in limited numbers and then buy the F-16 in greater numbers, thus ensuring that both "capability" and "quantity" check boxes could be ticked. The IAF's priorities were to be able to fight for, and maintain, air superiority; fly deep interdiction missions; and provide long-range support. The F-15 could climb to 30,000ft and accelerate to 0.9 Mach for an intercept in less than one minute 30 seconds; it demonstrated excellent low speed handling characteristics; and its radar, HOTAS and HUD were immediate indicators to Paled that the Eagle would outclass Israel's opponents, nearly all of which were equipped and trained largely by the Soviets.

An order for 25 F-15A/Bs was placed in 1975, and the first three Eagles were delivered under the FMS program name *Peace Fox* on December 10, 1976. Although this represented only half of the quantity that the IAF had wanted, it was an expensive purchase, at $25m per aircraft. Interestingly, such was the urgency of Israel's order that four (eventually five) of the airframes delivered in the first batch came from the USAF's Developmental Test & Evaluation program.[2] The first of 19 brand new F-15As and two B models were delivered in late 1977 as Phase II of *Peace Fox*, or *Peace Fox II*, all arriving in-country by 1978.[3] All were operated by 133 *Tayeset* (Hebrew for squadron), which was newly established just for Israel's Eagles. In Israel, the Heyl Ha'Avir (Israeli Air Force, IAF) modified all of its F-15s to carry the Israeli-built Shafrir 2 IR AAM, as well as Rafael Python 3[4] advanced IR AAMs. The IAF designated the F-15 *Baz* (Falcon).

OPPOSITE
A JASDF F-15J prepares to take gas from a USAF KC-135. The JASDF's Eagles all feature metallic green air refueling slipway doors. (Steve Davies Collection)

The IAF initially sent five pilots to Luke AFB in the US to learn to fly the Eagle, and these men returned to Israel to create an intensive training program that rapidly brought more pilots up to speed. These were followed by five more four months later. In all, the initial cadre of IAF Eagle pilots flew training sorties for eighteen months before they flew their first combat mission. Four of these became the first to ever score an air-to-air kill in the F-15.

On June 27, 1979, Israel launched one of a series of air raids during this period, targeting Palestine Liberation Organization (PLO) terrorist bases, arms caches and training camps in southern Lebanon. This day's strike package included F-4 Phantoms and A-4 Skyhawks and these went north to hit a PLO terrorist base near Sidon, Lebanon. The Syrian AF challenged the raid by launching between eight and twelve MiG-21 "Fishbeds," but had not reckoned on the IAF's new F-15 Eagles and IAI Kfir C2s flying top cover for the raiders.[5]

The 133 *Tayeset* provided cover with a four-ship of F-15s, led by squadron commander LtCol Benyamin "Benny" Zinker, and supported by another formation of two F-15s and a pair of Kfir C2s from 101 *Tayeset*.[6] The first formation flew into Lebanon at 15,000ft and established a CAP orbit between Lake Karoun in the Bekaa Valley and the port of Sidon, with the second, mixed, formation in the same area, orbiting at 12,000ft about 30 miles behind the all-*Baz* formation. Meanwhile, IDF/AF (Israeli Defense Force/Air Force, the more formal IAF title) ground radar units and the Grumman E-2C Hawkeye[7] AWACS from 192 *Tayeset* reported that two or three formations of MiGs had taken off from a Syrian base (probably Rayak, Lebanon) to the northeast and were headed their way. The F-15s picked up the radar contacts, but were initially ordered to withdraw to the west, luring the MiGs well away from their base.

When given the order to "commit," LtCol Zinker turned his formation around, jettisoned fuel tanks, accelerated and soon located the approaching MiGs on radar. Zinker and his wingman, 5.5-kill ace Maj Moshe Melnik, both fired AIM-7F Sparrows and, in shades of Vietnam, neither of them worked and the Israelis were forced into a visual dogfight. The F-15 proved supreme and Maj Melnik (in No. 663) quickly got in behind one MiG-21 to shoot it down with a Rafael Python 3.

According to Melnik:

> A pair of MiG-21s crossed my flight path at a slightly lower altitude. At a certain point they changed the direction of their turn – a sign that they were paying attention to us. Five seconds passed from the moment I identified them to the moment I had one of them in my sights. I fired an accurate missile which split the MiG in two. Barely a minute passed and four more MiGs found themselves planted firmly in the ground. The radio was full of our pilots shouting "Hipalti! – I scored a kill!" The other MiGs started making their getaway and we intended to give chase, but eventually we had to give up.

One of these calling "Hipalti!" was Yoel Feldsho (in F-15B No. 704), who spotted a MiG-21 maneuvering towards the tail of Melnik's fighter and promptly shot it down with an AIM-7F. Meanwhile his flight leader, LtCol Ben-Eliyahu[8] (in No. 689), spotted two "Fishbeds" attempting to spiral out of the fight and he closed in for the kill. Following their former squadron commander into the fray, the mixed CAP, led by Yoram Peled (in No. 672), destroyed the trailing "Fishbed" with an AIM-9G while Ben-Eliyahu shifted his aim and destroyed the other MiG-21 with his F-15's M61A1 20mm Vulcan cannon.

By this time the surviving "Fishbeds" were all trying desperately to escape. One Kfir (No. 874 flown by Capt Shai Eshel) hit a fleeing fifth MiG with a Rafael Python 3 IR AAM;[9] the MiG pilot ejected safely.

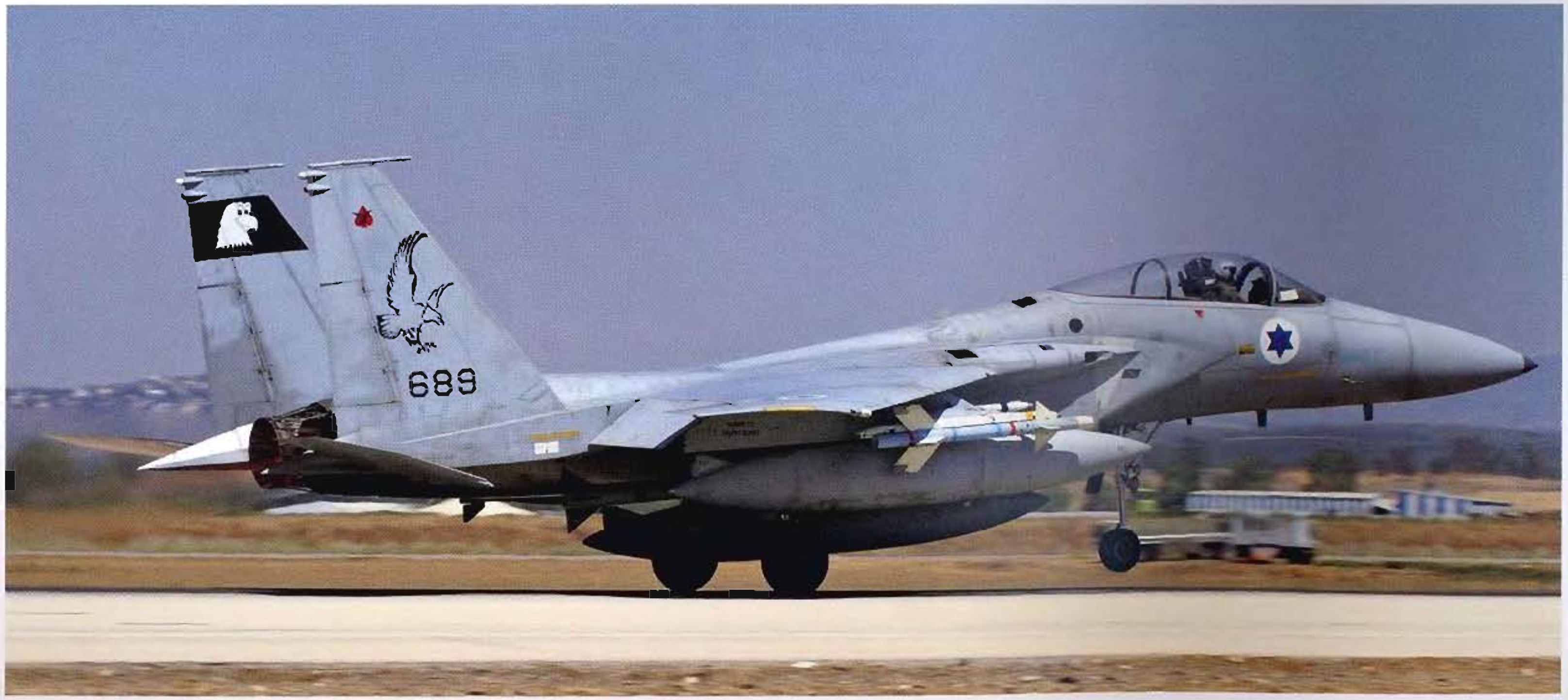
Aerial skirmishes such as these continued and by the end of 1980, the IAF Eagles had scored another six Syrian MiG kills with the F-15. On February 13, 1981, the IAF scored its eleventh victory, and in so doing made the F-15 the first aircraft ever to shoot down a MiG-25 "Foxbat." The highly touted MiG-25 was fairly new in the Middle East theater and had been challenging (though unsuccessfully thus far) IAF overflights of Lebanon for some time. This time a pair of McDonnell Douglas RF-4E reconnaissance Phantoms had LtCol Zinker (flying No. 672) escorting them on a run across Lebanon. The RF-4s were at 40,000ft, scorching along at over Mach 1.0 with Zinker about 20,000ft beneath them in what appears to have been a pre-arranged "Foxbat" trap. Two "Foxbats" launched and were quickly at the Phantoms' altitude and approaching at high Mach. The unarmed RF-4Es dumped chaff and sliced away to return to Israel while Zinker locked up the lead "Foxbat," zoom climbed to 30,000ft and unleashed three AIM-7Fs. This time the Sparrows worked as promised and one "Foxbat" was flamed. The other fled back to its base.[10]

While the IAF gave the F-15A the Hebrew name *Baz*, it named the F-16 (which began to arrive in 1980), *Netz*, or Hawk. The two types worked together in 1981 for Operation *Opera*, an Israeli strike on the Osirak/Tammuz[11] nuclear reactor complex at Al-Tuwaitha, about 12 miles (19km) southeast of Baghdad, Iraq. Eight F-16 strikers and six F-15A escorts ingressed the target on Sunday afternoon, June 7, 1981, taking off from Etzion, a forward operating base in the Sinai, and flying at 200ft across Saudi Arabia and Jordan. Approaching the target area, the escorting *Bazs* zoomed to 20,000ft and split off in pairs to establish three CAPs while the F-16s popped up, rolled inverted, acquired their target visually, and each delivered two (sixteen total) Mk 84 LDGP (low-drag general-purpose, 2,000lb) bombs.[12] All fourteen IAF aircraft recovered safely from the 1,370-mile round-trip mission.

Peace Fox III followed in 1981 with the delivery of eighteen F-15C and eight F-15D *Akevs* (Buzzards), to establish 106 *Tayeset*. One year later the squadron was declared IOC on the type.

For air-to-ground duties, Israel's Eagles are equipped with US and indigenous laser-guided bombs, US-supplied data link pods and the TV-guided, stand-off GBU-15 2,000lb glide bomb, and it is not unusual to see CFTs fitted to C- and D-model *Akevs* for additional fuel and weapons carriage. To this end, the Israelis have also modified the fuel plumbing in their A- and B-models to permit carriage of CFTs, in doing so extending their reach and making long-distance strikes more feasible. They are the only A/B-model operator to have undertaken such modifications.

BELOW
An IAF F-15A (76-1518) takes to the skies from Tel Nov AB, Israel. Israel routinely operates its Eagles in a variety of configurations. This jet has a loadout including "three bags," two AIM-7 Sparrows on the right fuselage station, an AIM-120B AMRAAM on the rear left fuselage station, a Python 3 IR AAM on the outboard wing pylon, and an Ehud ACMI pod on the inboard wing pylon (Nir Ben-Yosef. (IDF/AF Magazine): www.xnir.com)



Operation *Drugstore*:[13] "The sure cure for that IADS Headache that's bothering you

By June 1982, the Lebanese Civil War had been going on – off and on – for seven years. It began as a conflict between Christian Planange Party militia and various Muslim factions, including the PLO (which had been in Lebanon since 1970, following its ousting from Jordan). In May 1976 the Syrians added their troops, tanks and aircraft to the mix, ostensibly to stabilize the situation but ultimately to support the Muslim factions and PLO, securing the Damascus–Beirut highway that stretches across central Lebanon. To provide coverage for its south flank – facing Israel – the Syrian 10th Armored Division later deployed across the Bekaa Valley. To protect it from Israeli air raids the Syrians deployed three brigades – totaling 19 batteries – of SAMs. These included two batteries of SA-2s, two of SA-3s and 15 of the new and highly effective SA-6 "Gainful."[14]

Believing a Christian government in Lebanon was better than a Muslim one, Israel supported the former while attempting to "punish" the PLO for its occasional bombardments and terrorist attacks against Israeli coastal and northern border settlements. Knowing that it might eventually have to push the PLO, and their Syrian "protectors" out of southern Lebanon, the IAF kept up a pattern of reconnaissance missions that kept watch over PLO bases and movements as well as photographing Syrian SAM battery positions, and collected "electronic order of battle" (i.e. radar frequencies, reaction times, etc.) information. Since overflight of the SAM sites was extremely risky, the Israelis resorted to using their Ryan Teledyne Firebee II reconnaissance drones.[15]

In late May and early June 1982, the PLO conducted a 12-day artillery/rocket bombardment of northern Israel that caused 60 civilian casualties, brought life in Galilee to a standstill and saw Israelis fleeing their homes and settlements for the first time since 1947. On June 3, the last straw was the PLO's attempted assassination of the Israeli ambassador in London. The Israeli government ordered a full-scale ground invasion[16] to remove the persistent PLO threat once and for all. At 11:00 hours on June 6, elements of seven Israeli mechanized divisions – 60,000 troops and 500 tanks – crossed the border into southern Lebanon in three wide columns: one up the coastal plain, one through the Lebanese mountains and the third into the Bekaa Valley to keep the Syrians from intervening.

Fighting was heavy and in spite of Israeli pleas for the Syrians to stand aside, the two sides clashed in a series of engagements and Israeli fighters shot down seven Syrian MiGs in the first three days of the campaign. On the ground, the western force of the offensive made good progress up the coastal plain until it stalled in front of Sidon, while the center force overcame PLO resistance in the ancient Beaufort Castle[17] on June 8, opening the Bekaa Valley to further advances and the clash of Syrian and Israeli troops and tanks the next day. These began under the protective umbrella of five SA-6 batteries that had moved south to fend off IAF air attacks. This in turn necessitated a dedicated campaign to eradicate the high-threat SAMs so that the IAF could continue to support the advance and its forces in combat.

The IDF/AF had been planning to do just that for several weeks. Having plotted the SAM site locations and learned their operating frequencies and modes, these were loaded electronically into Delilah SAM decoy drones, Keres truck-launched anti-radiation missiles (ARMs), and Ze'ev surface-to-surface missiles (SSMs).[18] In order to give the impression of a large raid driving deep into the Syrian SAM defenses, numerous Delilah decoys were launched. As the SA-6s began engaging them, at 14:00 hours the Keres ARMs and Ze'ev SSMs were launched, pummeling the Syrian SAM batteries with repeated hits. In the first ten minutes, ten batteries were either inoperable due to hits or because they had fired off all their ready missiles.

Four minutes later the first wave of fighter-bombers – 26 F-4Es and a number of Kfir C2s – swept in, the Phantoms attacking the batteries with AGM-65 Maverick TV-guided missiles, and AGM-45 Shrike and AGM-78 Standard ARMs, while the Kfirs hit SAM control vans and missile storage areas with "iron bombs." As the first wave departed, 40 A-4s and Kfirs roared in, spreading cluster bombs across the SAM missile positions while specially configured F-4Es used 2,000lb laser-guided bombs against surviving radar sites and control vans. By the time this wave turned south at 14:35hours, 17 of the 19 SAM batteries had been knocked out.

The third wave of fighter-bombers swept in and attacked the Syrian mobile GCI sites, completing the blinding of the Syrian air force IADS in the Bekaa Valley, while F-15s and F-16s established CAPs over the funeral pyres of the destroyed SAM sites. Their timing was good because as

Syrian air force leaders realized that their air defense network was being methodically dismantled, they scrambled three squadrons of "Fishbeds" and a number of "Floggers" (the total was estimated at 54 to 60 MiGs) to attack the Israeli fighter-bombers in the Bekaa Valley. However, what they found instead were formations of F-15s and F-16s – controlled by Grumman E-2C AWACS that spotted the MiGs approaching and had a very clear picture of air activity in the valley – waiting for them.

The MiG-21s and -23s were at an almost total disadvantage against the Israeli F-15s and F-16s. While the Israeli fighters had long-range radars allowing them to position themselves advantageously for the attack, the MiGs were limited to initial GCI vectors from radar sites back in Syria, and as they approached the Israeli fighters, electronic jamming rendered their radars useless and disrupted their radio contact with the Syria-based GCI units. As one Syrian pilot reported: "When we closed to 10–15km [6–9 miles] to the enemy, our radars would go black and we would lose all means of detecting them. Heavy jamming wasn't concentrated on our radars alone, but also on our communications with ground control."[19]

Additionally, the Syrian MiGs were armed almost exclusively with old, stern-only IR missiles which required maneuvering to firing positions behind the enemy, whereas the IDF/AF fighters had front-aspect radar (AIM-7F) and IR (Python 3) missiles. The Syrian tactics largely employed frontal attacks into these weapons, attempting to maneuver to the rear quarter only if they survived the initial merge with the enemy. Many Syrian MiGs were blasted from the sky before they ever saw or met their adversary at the merge. Without GCI to warn them that they were being ambushed, ten "Fishbeds"[20] were shot down, half of them by the *Akevs* and *Bazs*, which also claimed four "Floggers" destroyed.[21] One F-15A was badly damaged by a MiG-21bis using a Vympel R-60 (AA-8 "Aphid") IR AAM; the Israeli pilot landed his crippled *Akev* safely at Ramat-David AB.[22]

The following morning the air battle resumed with Phantoms and Kfirs destroying the two remaining SAM batteries while F-15s and F-16s engaged the Syrian MiG-21s and -23s sent in to make up for the lost missile defenses. The F-15s took on the more capable MiG-23s and were credited with destroying six of them. Additionally, since Syrian tank units were being attacked by Israeli armored forces, the Syrian air force attempted to disrupt the Israeli columns with air attacks by Su-22 "Fitter" attack aircraft. Two squadron-size waves, each escorted by a squadron of MiG-21s approached, closely packed, one wave right behind the other in the hope that the F-15s and F-16s engaging the first wave would allow the second wave to pass through relatively unmolested. Consequently, the first wave suffered grievously, reportedly losing six "Fitters," and it was a massacre for the "Fishbeds," with 14 MiG-21s falling to the advanced US-made fighters, most of their pilots being killed. Six were shot down by *Akevs* and *Bazs*. Additionally, one IAF F-15 shot down a Syrian SA342L Gazelle helicopter that followed up the "Fitter" attack by firing HOT anti-tank missiles into Israeli armored units.

June 11 was the last day of continuous combat as a hastily bartered ceasefire went into effect at noon that day. Nevertheless, both sides fought with renewed vigor. To help the Syrian ground forces stave off defeat, the Syrian air force introduced larger numbers of "Floggers" into the air battle using air-to-air MiG-23MFs and MSs to engage IAF F-15/16s, while the more limited MiG-21s provided close escort to defend the MiG-23BN air-to-ground "Flogger-Fs." Additionally Syrian air force MiG-25s flew high-speed, high-altitude profiles over the Bekaa Valley in an attempt to lure the Israeli fighters to "look up" with their radars and thus decoy them away from the strike formations ingressing at low altitudes.[23]

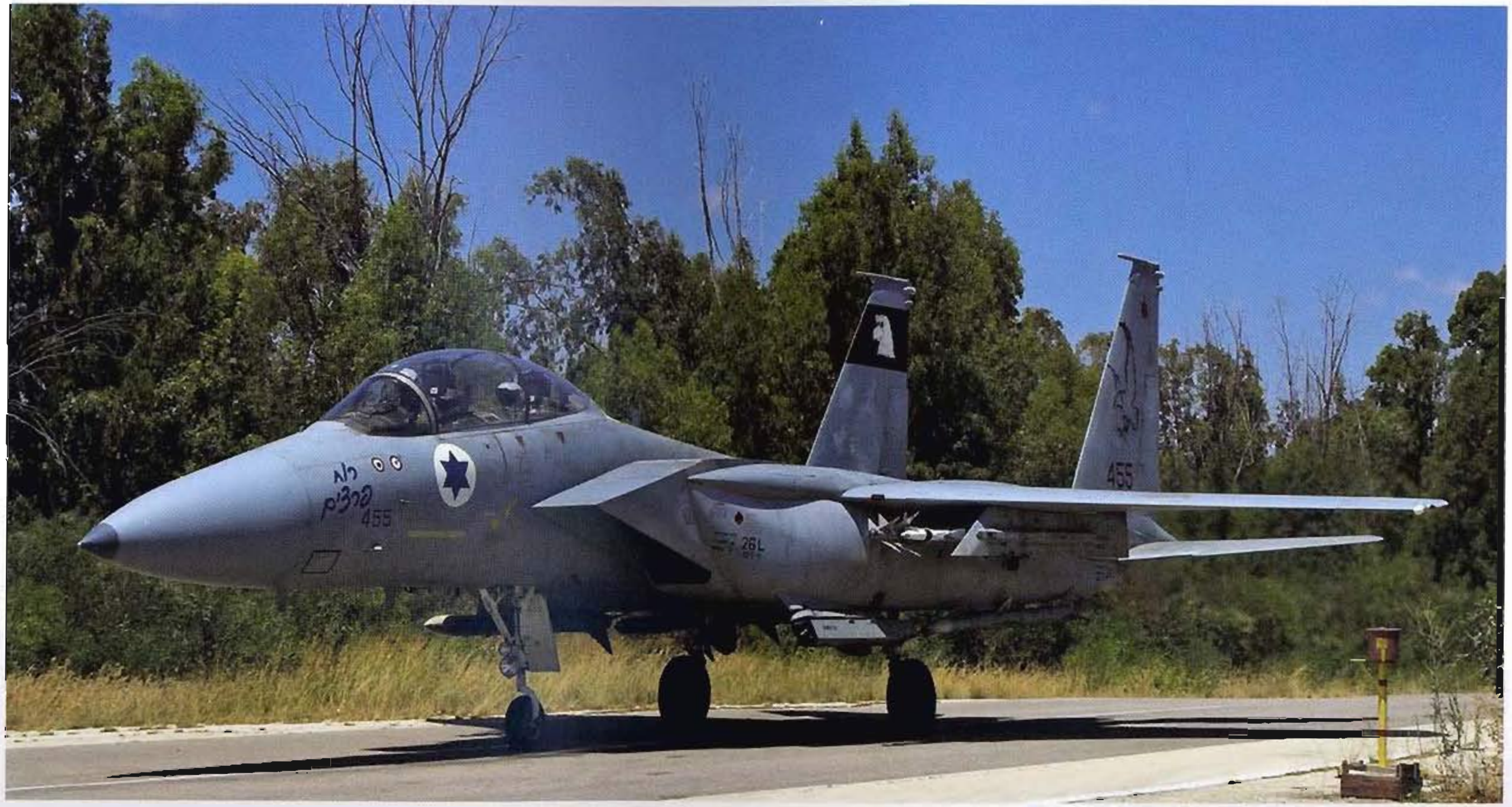
Down low, the Syrians repeated their tactics of the prior day with two large waves of air-to-ground MiG-23BNs (each squadron sized) ingressing at low altitudes, each escorted by a squadron (or what remained of one) of MiG-21s. At medium altitudes, the sweep by the air-to-air "Flogger-Bs" and "Es" failed to keep the F-15s and F-16s away from them and again serious losses occurred. Overall, seven "Flogger-Fs" were lost to IAF fighters and another to an Israeli army MIM-23B I-Hawk SAM. The MiG-21s providing close escort lost six of their number in a series of engagements, half to F-15s.

Officially the Israelis claimed that 88 Syrian aircraft[24] were shot down during June 5–12, 1982. IAF F-15s were credited with 33 victories. Another 44 kills were claimed by IAF F-16s and one IAF F-4E was credited with shooting down a Syrian MiG. The Israeli losses have never been satisfactorily admitted, but are believed to have totaled 13 aircraft: including one F-16A, one F-4E, one Kfir, two A-4s and several helicopters.

The Eagle's air-to-ground capability has often been overlooked since the USAF was never truly interested in utilising the Eagle in any role other than air-to-air. However, the Eagle was built from the word go with a modest capability against ground targets. During AFDT&E in 1974, the F-15 had been cleared to operate in the air-to-ground role, always with the caution that it should not impede or influence the Eagle's progress and capabilities in the air-to-air role. The process involved establishing that the automatic A/G delivery modes[25] provided by the radar and HUD were trouble-free and that they offered a level of accuracy equivalent to that of a dedicated A/G aircraft.[26] More than 100 multi-carriage bomb loads were jettisoned or separated up to Mach 1.4, and flutter testing had been completed in three main configurations: clean, external fuel tanks, and with one Mk 82 500lb LDGP unguided bomb under each wing. The AFDT&E figures show the Eagle demonstrated an average miss distance of only 75ft when dropping bombs from 10,000ft in a 45-degree dive.

In what was undoubtedly another "first" for the Eagle, the IAF used bombed-up F-15B/Ds to strike a PLO headquarters and barracks in Tunis, flying a 2,560-mile round trip in October 1985. For this mission six F-15B/Ds were configured with a GBU-15 under the left wing, the data link (bomb guidance) pod on the centerline

BELOW
Israel operates its two-seat "family model" B/D Eagles in combat with equal enthusiasm to its ICS-equipped A/C-models. This Eagle, F-15B No. 455, boasts CFTs, an IAI/Elta EL/L-8222 ECM pod, a Python 4 IR AAM, two AIM-7Fs and a single AIM-120A AMRAAM. It carries two Syrian roundels beneath its windscreen. The forward marking denotes a kill, while the aft marking, a roundel being penetrated by a bomb, shows that No. 455 took part in the 1985 raid against the PLO headquarters in Tunis. (Nir Ben-Yosef (IDF/AF Magazine): www.xnir.com)



and an external fuel tank under the right wing. The last two strikers were F-15Cs carrying two external tanks under the wings and a rack of six Mk 82 500lb LDGP "dumb bombs" each on their centerlines.[27] The long-range raid was enabled by air-to-air refueling from two IAI-modified Boeing 707 tankers.

Interestingly, *Akevs* have also been photographed carrying an unidentified reconnaissance pod on the centerline station. The pod, which would seem to have been fashioned from a standard fuel tank, has two windows at 90 degrees from the centerline, and appears to house an optical sensor payload.

Peace Fox IV delivered an additional five F-15Ds in 1989. These were F-15E airframes (the F-15C/D production line converted to F-15E in 1986) with cockpits built to D-standard. Reportedly this was so that these jets could be modified for use in the Suppression of Enemy Air Defenses (SEAD, commonly known as Wild Weasel) role.[28]

The most recent Israeli acquisition of the light gray (fighter) F-15 came following Operation *Desert Storm* as *Peace Fox V*, when the US Government offered the IAF 25 (mostly ex-Air National Guard) F-15A/Bs at a discounted price. These were base models that had not received the MSIP upgrade, and they were all 1973/1974-build airframes. Reportedly they were allocated to 148 *Tayeset*, but there is no evidence that 148 *Tayeset* is an operating unit. More likely, 148 *Tayeset* is simply a holding or storage unit (called a "reserve" unit by the IAF) for F-15A/B attrition reserves. Despite being claimed to be in good condition when they were flown to Israel, by 2001 the Israelis had retired all but one of the Peace Fox V Eagles, with most being sent into storage at Ovda AFB, or cannibalized for spares as early as 1992 and 1993.[29] This, it has been suggested, was because the IAF found them to be in poor condition.[30]

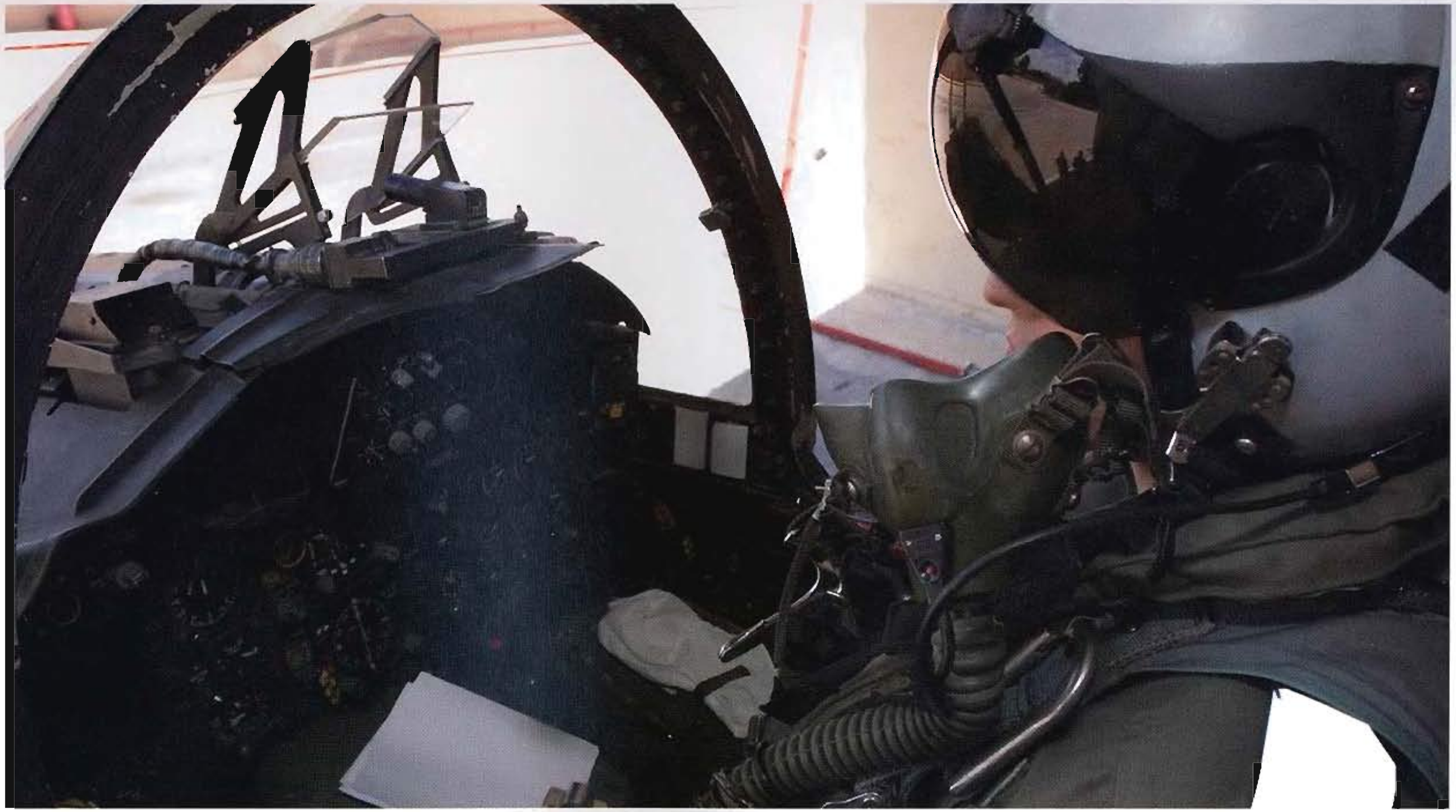
All FMS Eagles are subject to US export laws tailored specifically to each customer. The *Baz* and *Akev* aircraft were delivered minus some components usually found within the Tactical Electronic Warfare Set (specifically, the ALQ-128 and ALQ-135). Additionally, the APG-63 had had its modes "detuned" to offer a reduced detection and tracking capability when compared to US models. Similarly, other classified US-only radar modes were deleted entirely. Israel has installed its own Elisra EW suite to replace the missing US components, and this includes the installation of indigenous chaff/flare dispensers and an internal ECM suite. The initial delivery of Eagles in 1975 saw the aircraft equipped with the IC-7 ejection seat, but later deliveries included the ACES II seat. A new EW suite is due to be installed, and Israeli F-15s are often seen carrying the IAI/Elta EL/L-8222 ECM pod on the forward, port-side fuselage weapon station.

Coinciding with the arrival of the strike-optimized F-15I in 1992, Israel initiated the *Baz Meshopar* (Improved Falcon) upgrade program in conjunction with Elbit Systems. A modernized cockpit, embedded GPS/INS navigation system, and DASH (Display And Sight Helmet) helmet-mounted cueing system were all crammed into what has become known as the F-15 AUP (Avionics Upgrade Program). The first upgraded aircraft returned to service in August 1998.[31] The USAF was intrinsically involved in the AUP, supplying hardware and software modifications and upgrades to incorporate the AIM-120 AMRAAM. The IAF was heavily dependent on the facilities offered by Eglin AFB, Florida to test the integration of AMRAAM.

To date, all F-15B/D airframes have been brought up to the *Baz Meshopar* standard, and the remainder of Israel's fleet should have been processed by late 2007. The upgrade sees the installation of 1760 MUX data bus wiring, a new Elbit-manufactured multifunction display (MFD) for the front cockpit, and three more for the rear cockpit of the F-15B/Ds. There is also a new programable armament control set (PACS) based on that found in the F-15E, an F-15E stick grip identical to that used by MSIP USAF Eagles, and support for the Rafael Python 4 air-to-air missile.

The decision to upgrade the *Akev* and *Baz* fleet was driven by the need to optimize the Eagle for future and emerging threats and opponents, and has paved the way for a second update that concentrates on the integration of new weapons and a revised EW suite. The second upgrade validates speculation that the priority given to upgrading the B/D-models ahead of the A/C-models was driven by the Israelis' propensity to regularly use these aircraft as fighter-bombers. The "family model" *Bazs* and *Akevs* occasionally complement the small contingent of 25 F-15I Strike Eagles purchased by Israel in the early 1990s, and as such Israel's modification to allow the B-model to carry CFTs reflects the need to allow the types to operate together whenever the need arises.

While the second, as yet unnamed upgrade will no doubt add Python 5 and Derby air-to-air missiles to Israeli Eagles, the



ABOVE
Israel's Improved Baz program modified the aircraft's cockpit and avionics to bring the Eagle closer in standard to the F-15I. Noteworthy are the new display and the all-black panels that are a feature of IAF Eagles. The rear cockpit more closely resembles that of a Strike Eagle than a typical "light gray" Eagle. (Nir Ben-Yosef (IDF/AF Magazine); www.xnir.com)

emphasis is on the integration of the latest Israeli precision weapons, and in particular those that allow the launch aircraft to control them after launch. Such weapons are designed with a second crewmember in mind – hence the emphasis on the B/D Eagle fleet. One such weapon is the Rafael AGM-142 Popeye stand-off air-to-ground guided missile, which Israeli F-15B/Ds are sometimes seen carrying. Finally, as well as future purchases of the JASSM and JSOW,[32] there is also a new generation of Israeli-made precision weapons, including satellite-guided bombs based closely on the American JDAM;[33] the Spice GPS bomb also has an optical sensor onboard, permitting a weapons system officer in the back of an Eagle to guide the weapon onto the target. The new PACS and MFDs installed under *Baz Meshopar* are intended to be used precisely for such a purpose.

The IAF has modified its Eagles to permit covert scrambles. The two main modifications include the deletion of the weight-on-wheels (WoW) override switch that prevents the radar from transmitting while the aircraft is still on the ground, and the installation of a comm port on the underside of the fuselage into which is plugged a cable that allows the tower to provide target information without having to broadcast it over the radio. Removal of the WoW switch enables Eagles sitting on QRA duty to scan a volume of sky ahead of them (assuming that they face towards the expected direction of the target, and that their radars are not "zapping" friendly personnel in their scan volume); while a "radio-less" scramble denies the enemy the opportunity to eavesdrop on scramble vectors and commands, thus allowing the Eagles to operate more discreetly.

To date, the IAF claims to have downed 50 enemy aircraft[34] (including a MiG-25 kill shared with a Raytheon MIM-23B Improved-Hawk missile battery, a MiG-21 shared with an F-4E, and two MiG-21s that maneuverd into the ground while combating F-15s) with the Eagle, for a loss of not a single aircraft. One F-15A (No. 686), was badly damaged by an R-60/AA-8 "Aphid" AAM (fired by a MiG-21bis at the end of a hard fought 4 v 4 engagement that saw the destruction of three MiGs) on June 9, 1982. The Syrians also claimed one F-15 shot down on December 24, 1983 but this is not confirmed. On the other hand, several IAF Eagles have scored multiple kills, perhaps the most famous of which is F-15C No. 840 (80-0129) nicknamed *Commando*,[35] with a total of six Syrian kill markings emblazoned beneath the windscreen.

While reportedly not losing any Eagles to enemy action, the IAF had lost nine F-15s in peacetime accidents by late 2006.

PEACE SUN F-15C/D

The Royal Saudi Air Force (RSAF) traditionally relied upon British hardware for its air defense needs, but the limited capabilities of its ageing fleet of English Electric Lighting F.Mk 52 and F.Mk 53 aircraft, and the overthrow of the Shah of Iran, left the Kingdom of Saudi Arabia feeling distinctly exposed in the early 1980s.

RSAF leadership initially wanted to purchase the F-14 Tomcat in order to provide both a long-range shield with which to deter the Soviets, as well as to counter the fact that the Iranian Shah's F-14s had fallen into potentially hostile hands. It was the F-15, however, that was eventually selected to complement the purchase of five E-3A AWACS delivered in 1982: 46 F-15Cs (minus some TEWS elements and radar modes) and 16 F-15Ds were purchased.[36] The first of these arrived on August 11, 1981 and 60 jets (two were held in the US as attrition replacements) were distributed between three squadrons: No. 5 Squadron at King Fahad AB, Taif; No. 6 Squadron at King Khaled AB, Khamis Mushayt; and No. 13 Squadron at King Abdulla Aziz AB, Dhahran.

To placate an agitated Israeli government, US Congress ruled that supply to the RSAF of the F-15C/D's range-extending CFTs would be limited, and that no more than sixty F-15s could be operated by Saudi Arabia at any one time. This led to two attrition replacements from the order of 62 airframes being held in reserve in the US. In 1990, and with some haste, this limit was lifted when Kuwait was invaded by Iraqi forces. An additional 24 F-15C/D aircraft were rushed to the RSAF that September from frontline USAFE units (12 each from the 32nd TFS at Soesterberg and 36th TFW at Bitburg). It is possible that the Iraqi threat also prompted US Congress to permit the release of the ALQ-135 ICS already fitted to these aircraft, although this cannot be confirmed. While the ALQ-128 was deleted prior to delivery, these jets retained the empty pods atop the left vertical stabilizer. These jets were used to equip No. 42 Squadron at Prince Sultan AB, Riyadh.

Early in 1989 Saudi Arabia had ordered 12 F-15C/Ds as attrition replacements, having lost four F-15Cs in the first eight years of Eagle operations. These materialized as *Peace Sun VI*'s nine C-models and three D-models, the latter made from F-15E airframes.[37] Between 1996 and 2001 all of the Saudi's C-models were converted to MSIP standard, with deliveries to Saudi Arabia of the VHSIC CC beginning in February 1997. Seventy-nine VHSICs were ordered in total to replace the existing AP-1R CC.

Saudi Eagles have seen little combat action, and certainly nothing like the level of use of their Israeli counterparts, yet they have been used to full effect when necessary. They are credited with destroying two Iranian F-4E[38]s (by two No. 13 Squadron jets using AIM-7s) that crossed the Gulf and attempted to penetrate Saudi airspace on June 5, 1984, and with the destruction of two Iraqi Mirage F1EQs (by one No. 13 Squadron jet using AIM-9Ps) during Operation *Desert Storm*.[39]

While no RSAF aircraft have been lost in combat, one F-15C was used in a Saudi defection to Khartoum, Sudan, on February 14, 1991, towards the end of Operation *Desert Storm*. The pilot, a member of No. 5 Squadron, took off from King Fahad AB, Taif, as one of a two-ship, flying aircraft No. 514 (80-0074) and was reported to the ODS Coalition Combined Air Operations Center

(CAOC) as having crashed on a routine training mission. The CAOC was about to mount a search and rescue mission to locate the downed aircraft when a CIA operative monitoring Khartoum airport called up and asked: "What's this Saudi F-15 doing on the ramp here?" The aircraft was later returned to Saudi Arabia – the pilot alledgedly later stating that he could not fight against his Muslim brothers – and was confirmed back on strength with No. 5 Squadron in July 1994.

This event, while widely hushed up, does not make it easy to see the RSAF as a serious belligerent, especially in conflicts with its Arab neighbours. In fact, the competency of the RSAF has long been held in question. Those US Air Force, defense contractor and ex-patriot personnel who have served flying and maintenance exchanges with the Saudis, or worked directly for them, invariably return shaking their heads with disbelief. One pilot who returned from an exchange tour flying the Eagle with the RSAF had two very mixed messages about their pilots. On the one hand, he described two of the best Saudi Eagle pilots, each with more than 3,000 hours in the jet, as being the best "sticks" he'd ever flown with or against, to include his USAF brethren. On the other, he rated the ability of the average Saudi fighter pilot as being below par.

In contrast to the air forces of many Western countries, the Saudi AF has a reported inability to generate sorties. One practice that serves to highlight this is the predisposition to never launch sorties that combine a range of flying and tactical skills into a single exercise. For example, a USAF pilot who needed to maintain currency in air refueling would most likely plan a four-ship sortie that would involve going out to the area and flying 2 v 2 engagements until he was out of gas; hitting the tanker and refueling; splitting into two, two-ship elements and then doing some 1 v 1 work; hitting the tanker once more; and then heading home for practice in the radar or visual pattern. Typically a Saudi pilot in the same situation would only fly out to the tanker, refuel once and then come home and land. There would be no attempt to integrate the whole set of core skills into one sortie in order to maximize training potential.

The RSAF had lost seven F-15Cs to peacetime accidents through 2002, and reportedly has lost another three Eagles (two "Cs" and an S-model) in as many years since 2003.

PEACE EAGLE F-15J/DJ

The Japan Air Self Defense Force (*Nihon Koku Jietai*, or JASDF) is the world's largest export customer for the F-15, with a total of 213 F-15J and F-15DJ – almost identical to USAF F-15C and F-15D, respectively – aircraft, 14 of which were bought under FMS program *Peace Eagle*.

The Japanese first test flew the F-15C and D Eagle in June and July 1975, respectively, as part of an evaluation of 13 different airframes to fill their air superiority fighter requirement, and to replace first the F-104J Starfighter and then the F-4EJ Phantom. The JASDF selected the F-15J and DJ, albeit with the now-familiar non-export items deleted and in April 1978 the Japanese government secured a license for a conglomerate of companies, led by Mitsubishi Heavy Industries, to manufacture the Eagle at Komaki.

The initial Peace Eagle complement was two F-15J (79-0280 and 0291) and six two-seat F-15DJs (79-0282 through 0287), followed later by two batches of four (81-0068 through 0071) and two (83-0052 and 0053). All these were built at McDonnell Douglas' St. Louis plant, the first F-15J being delivered to the JASDF on July 15, 1980 (first flight June 4, 1980). Additionally, another eight single-seat F-15Js were manufactured in St. Louis in large components and shipped to Japan in kit form for final construction by Mitsubishi. The remaining 199 examples were produced indigenously.

The first of the Mitsubishi-assembled kits was serial number 12-8803[40] which first flew on August 26, 1981. Later that year the first F-15J/DJs went to 202 *Hiko-tai* (since redesignated as the 23 Flying Training Squadron) at Nyutabaru AB, on the southern island of Kyushu, which became the Eagle FTU. The infamous KAL007 shoot-down by a Soviet Su-15TM "Flagon" on September 1, 1983 prompted the basing of the first operational squadron, 203 *Hiko-tai*, at Chitose AB, on the northern Hokkaido Island, across the waters from the three Soviet fighter bases on Sakhalin Island, replacing the extremely limited F-104J Starfighter.

Over the next four years new F-15Js replaced Starfighters in 201 and 204 *Hiko-tais* and in 1986/87 began to replace F-4EJ Phantom IIs in the 300-series "heavy fighter" *Hiko-tais*, the first being 303 *Hiko-tai* at Komatsu AB, on the west side of Honshu Island. Altogether there are now two wings (four squadrons) centrally

ROYAL SAUDI AIR FORCE

ABOVE
An RSAF F-15C Eagle take-off for a sortie during Operation *Desert Storm*. During the conflict the RSAF acted as a border controller in what became known as Goalie CAP. (USAF)

located on Honshu, one wing on Hokkaido, and a single squadron (304 *Hiko-tai*) on the southern Kyushu Island. Originally these JASDF Eagle squadrons were equipped with 18 fighters each, but very low attrition (just ten losses up until 2000), have allowed the units to strengthen to 22 jets apiece, with 203 *Hiko-tai* being the first to grow (in 1987).

The Japanese F-15s were originally powered by F100-PW-100 engines, but 1992 saw the fleet benefit from a re-engine program to the PW-220 and, in 1996, to the PW-220E, an improved version of the PW-220. At the time of writing, most of Japan's Eagles had been re-engined, although the Eagle training school operates PW-100 equipped Eagles for the most part.

The F-15J/DJ has the same basic cockpit layout as the F-15C/D, and all placards are in English. From an avionics perspective, Japanese Eagles boast a number of key differences to US Eagles. Some still feature an IMU (inertial measurement unit, an older version of the inertial navigation unit used now by the USAF), and every jet has two "old" UHF-capable radios, which are also VHF capable. The F-15J features an entirely indigenous TEWS suite that JASDF pilots have been known not to speak highly of, but other non-Japanese sources have claimed is effective. The external differences that give away the different EW fit include the J-models' J/ALQ-8 ICS antennas mounted under the intakes, and the J/APQ-4 RWR antennas for both "J" and "DJ" Eagles being in the usual position, but featuring black lenses (as opposed to the A/B/C/D-models' white). The F-15J also features an indigenous data link, but it is not comparable to the Link 16 FDL in USAF Eagles. The data link is somewhat limited insofar as it acts as a basic two-way link to a ground control intercept (GCI) station and is not a true network – to which you can add "players" – like FDL. The device is used on most intercept sorties, but displays only letters that show range and azimuth that the weapons controller can send to the pilot on the radar display, and HUD carats (triangular pointers) that show altitude, heading, and airspeed directions. Approximately half of Japan's Eagles have an MPCD, but the display is not used for either moving map or data link purposes, and is treated as little more than a sophisticated PACS panel.

Reportedly, basic Japanese F-15 life support equipment is said to be less comfortable to wear than the US equipment, and includes the Shoei FHG-2 flight helmet; LPU-H1 and JPCU-3/P life jacket and parachute harness; and JG-5A anti-g suit.

Like the Royal Saudi Air Force, the *Nihon Koku Jietai* maintains an exchange program whereby USAF Eagle pilots with instructional experience are assigned to fly a tour with the 23rd Flying Training Squadron, Nyutabaru Air Base – the Japanese equivalent of the FTU at Tyndall. One such pilot serving with the 23rd FTS in 2006 was Maj Justin "Ringo" Fletcher, who had more than 1,700 hours in the Eagle, including almost 880 hours as an IP.[41]

BELOW
A JASDF F-15J belonging to the 2nd *Koku-dan* taxis back to the ramp at Chitose as an A300 takes off from the opposite runway. The *Koku-dan* consists of 201 *Hiko-tai* and 203 *Hiko-tai*. (Erik Sleutelberg: www.keymountain.nl)

JAS
42-8949
949

His first task was to take leave of the cockpit in order to master the Japanese language:

> I spent one year in Tokyo's Kichijoji Language School learning Japanese during my first year of the exchange tour. I showed up day one not really knowing any Japanese other than the basic greetings. That was a great year as I grew out my facial hair and enjoyed 'civilian life' for a year, but it was truly the "fire hose effect" from day one. The language school itself was by far the hardest thing I've ever undertaken – I had headaches at night constantly. It was much harder mentally than I prepared myself for.

This academia-induced trauma was mandatory, Fletcher explained, because fewer than half of the F-15J/DJ's manuals are written in English. "Much of the *Dash One* pilot's manual is in Japanese with some English terms thrown in for good measure. However, all the flying manuals are in Japanese. The Japanese use Katakana dialect and a lot of foreign words, and therefore most of the English they speak is really Japanese-English, or what I call 'Jenglish.'"

Fletcher qualified in the J-model Eagle having attended 30 hours of ground academics, "flown" three simulator rides and 22 F-15DJ sorties. "I also rode quite a bit in the backseat to become familiar with 'Jenglish' and Japanese flying terms. Once I started the IP upgrade I had 26 sorties including both 'see' and 'do' rides. From the time I arrived at Nyutabaru and finally finished the program it lasted seven months," he added.

The JASDF training pipeline prior to training with the Eagle includes approximately two years of flying the propeller-driven T-3, and two phases of T-4 fast jet school, to make a total of about 220 hours flying time. Fletcher reckons that "approximately 90 people start pilot training every year, about 60–70 percent of those students go to T-4 training [fighter track], and the others go to T-400 [rescue/cargo track]. They are then split between F-15 and F-2 training. Those who graduate from the F-2 can then fly either the F-2 or go to the F-4EJ Kai, in which case they go through the F-4 RTU."

The new Eagle students then arrive at Nyutabaru for training in the F-15 and fly 79 sorties for 100 hours in approximately ten months.[42] Teaching new Eagle students takes on a quite different

ABOVE
The JASDF's aggressor Eagles are most famous for their colorful camouflage schemes. The *Hiko Kyodo-tai* operates from Nyutabaru AB, Kyosho Island, and fulfills a test and evaluation mission in addition to providing aggressor training. (Andreas Zeitler: http://www.flying-wings.com/)

form to that Fletcher had become accustomed to Stateside. "The B-course here is completely different than the way Tyndall does it. I look at their training much more like our IFF introduction to fighter fundamentals[43] training in the US. The JASDF philosophy is one that 'safety is the number one factor,' and approximately 90–95 percent of the sorties here are dual, whereas it is just the opposite at Tyndall." To this end, the 23rd FTS boasts eight J-models and 16 DJ-models. This total of 24 jets is more than the JASDF Eagle squadron, which usually has a complement of around 22 Eagles.

According to other sources, the lack of responsibility afforded the students and the constant supervision under which they learn, means that they graduate the B-course a long way from being Mission Ready (MR) when they arrive on their operational squadron. Instead, the wingmen arrive at their unit in what is considered a "training ready" status, and after approximately six months they become "alert ready"; six months later they are eligible to become "combat ready."

Fletcher's working week typically consists of five long days that stretch beyond 12 hours.

> Our typical work week is either an early or late week. The early report is at 06:30; the late report is 07:30. We will have three flying goes per day unless night flying, and then we have four. We generally fly nights on Monday and Tuesday. I will fly anywhere from six to eight times per week with about one to two simulator sorties and three to five assistant duty officer and mobile officer tours.

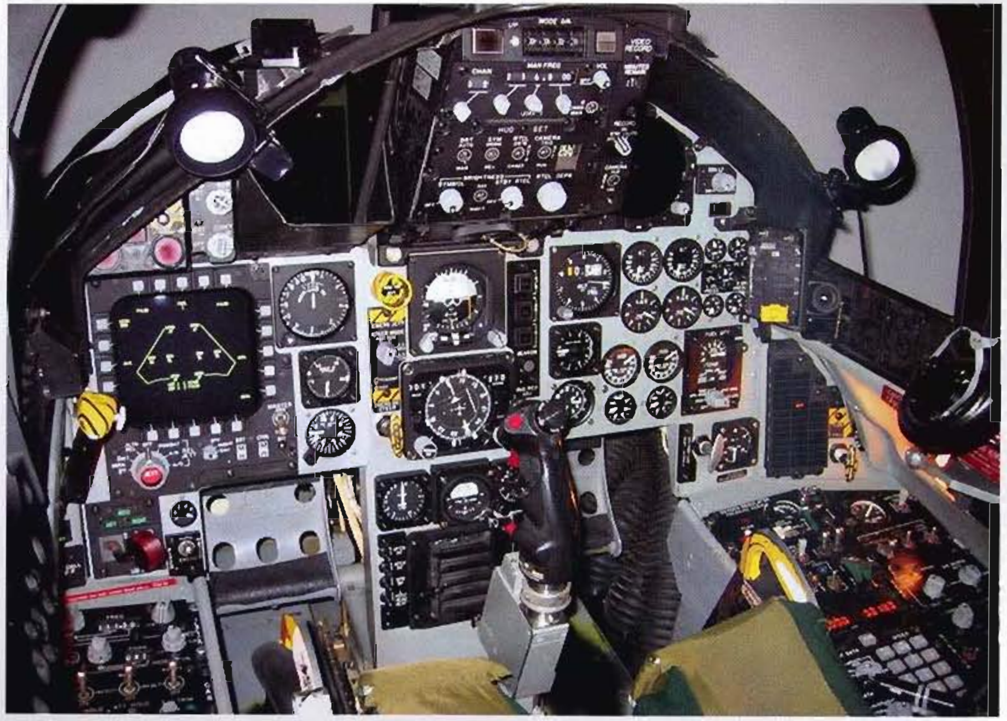
The purpose of his exchange with the JASDF is to provide "outside influence," although the Japanese are clear that they wish their students to learn about Japanese flying tactics and doctrine. This seems somewhat contradictory, but sometimes the exchange's goals are readily obvious: "Recently the squadron rewrote their training handbook for IPs here and I had some pretty good influence in rewriting the BFM section. So, hopefully down the road we will see some increase in abilities there."

Pre-flight briefings are conducted, "almost all in Japanese, and the 'flow' of them is basically the same as in the US," Fletcher explains. However, he was surprised to find that many of the briefers do not stand as they would in the US, and that the briefs are all conducted in one large, very noisy room. This is also in contrast to the individual rooms used by US squadrons. "The JASDF work ethic is unmatchable. It is in their culture to be there before the boss and not leave until after he leaves. Their professionalism once again is remarkably the same as regular Japanese lifestyle ... always professional! As I've become better friends with some of the guys they tell me the lifestyle is very hard in the Training Squadron and that they look forward to getting back to an Operational Squadron," Fletcher remarks. In addition, the JASDF does not employ a mandatory 12-hour crew rest rule between shifts for Eagle pilots, and, remarkably, nor does it have a bottle-to-throttle rule prohibiting alcohol consumption to a minimum of 12 hours before the next sortie. Both of these rules are enforced in the US as a method of ensuring safety in the jet, so it is surprising that the Japanese have not followed suit.

Once a year since 2003 a group of JASDF Eagles has participated in *Cooperative Cope Thunder*, a multinational exercise held by PACAF. Even so, JASDF Eagles are largely insular insofar as operating with other PACAF units stationed in Japan is concerned. Thus, F-15Js only occasionally operate with PACAF's F-15Cs based at Kadena AB. Fletcher has exerted some "outside" influence in this regard, however:

> I recently took three Japanese IPs down to Kadena for a cross-cultural exchange which helped the JASDF learn what US wingman duties and responsibilities entail. We were there for three days and each of the JASDF F-15 IPs was able to fly in an ACM sortie seeing from the back seat what we had discussed previously. They also sat through a full brief and KITS [Kadena Interim Training System] debrief.

Although many Japanese Eagle pilots have more hours than US Eagle pilots of the same number of years, several sources claim that they are generally not nearly the same caliber as their US counterparts in either tactical knowledge or flying abilities. Given the Japanese commitment to excellence and professionalism, this is probably partly down to the fact that JASDF Eagle Drivers do little to no BFM at their operational unit, instead concentrating on intercept training. In addition, Japanese culture dictates that the more experienced a pilot is, and the more qualifications he has, the more he gets to fly.



LEFT
The J-model cockpit simulator includes the MSIP MPCD, but uses the pre-MSIP stick grip that is associated with the quasi-MSIP mod carried out on some JASDF jets. Note the CMD panel in the far right corner, which can partially obscure the small hydraulic gauges behind it. This panel is common to all FMS Eagles, including the Israelis'. (Steve Davies Collection)

For live missile firings, Komatsu AB on the west coast of Japan (Honshu Island) is used. Running along similar lines to WSEP in the US, it generally involves some testing of weapons capabilities to ensure that the live missiles are not wasted. Japan employs a range of missiles for its Eagles: AIM-7, AIM-9L, AAM-3 (IR) and, in the future, the AAM-4 active radar missile and AAM-5 IR missile. Whereas US F-15 pilots rarely fire the gun in practice, JASDF pilots live fire the M61A1 three to four times each year in sorties that are flown from their home base.

Although plans were afoot in 2004 to equip the F-15J and F-15DJ with the APG-63(V)1 to replace the "vanilla" APG-63(V)0, Fletcher reports that only two aircraft have received the (V)1 and that there are no immediate plans to roll the radar out to the rest of the fleet. Until that changes, Japanese Eagles will continue to use old radar tapes that pre-dated even the Suite 1 tapes used by the USAF in the early 1980s.[44]

The F-15J/DJ utilizes indigenous software upgrades to the EW and CC that are unrelated to the USAF's cyclical OFP (Operational Flight Program). Approximately 30–40 aircraft have been updated with MSIP software, including an updated J/TEWS RWR[45] suite. One aircraft has so far also been the beneficiary of an updated ECS. Reports that the JASDF is considering installing updated IFF, RWR and CMD on its Eagles could prove to be ill-founded since Japan is known to be channelling as much money as possible into the F-2 and towards a future replacement fighter. While Japan is testing JHMCS with a pod-mounted IRST on the F-15J as part of its testing with the AA-5 missile, there are no plans currently to install either on the Eagle in frontline units.

Japan has a single squadron of eight F-15DJs and two F-15Js known as the Aggressor Squadron (*Hiko Kyodo-tai*). The squadron has a role similar to the USAF's 422nd Test & Evaluation Squadron at Nellis AFB, to develop tactics and evaluate new weapons systems. At one time the squadron was evaluating night vision goggles, but these are no longer used and have not been rolled out to the wider JASDF Eagle fleet. The aggressors, with their distinctively painted Eagles, have spent much of the last few years developing "new" tactics to go along with the AAM-4 (active radar missile). They have then visited the frontline squadrons and taught them how to get the most from the weapon. The Aggressors use a "DBSS" pod (Debriefing Support System) that resembles a scaled-down version of the KITS pod used by Kadena Eagles, but which is reported to have some problems keeping track during high-*g* maneuvers. In intercept- and ACM-type sorties DBSS performs well, but for BFM it therefore experiences quite a few problems. The Aggressors' D-models also carry an export version of the ALQ-131(V)5 ECM pod which features a training mode to allow use in their dedicated airspace. (The J-model's J/ALQ-8 ICS is similarly configured to permit local peacetime use.) It is rare to see an F-15DJ from the Aggressor squadron with an empty back seat, and since the second pilot is allowed to claim the flight as pilot in command time, this goes some way to explaining the large numbers of Japanese Eagle pilots with more than 3,000 hours under their belts.

80167

IMPROVED EAGLES

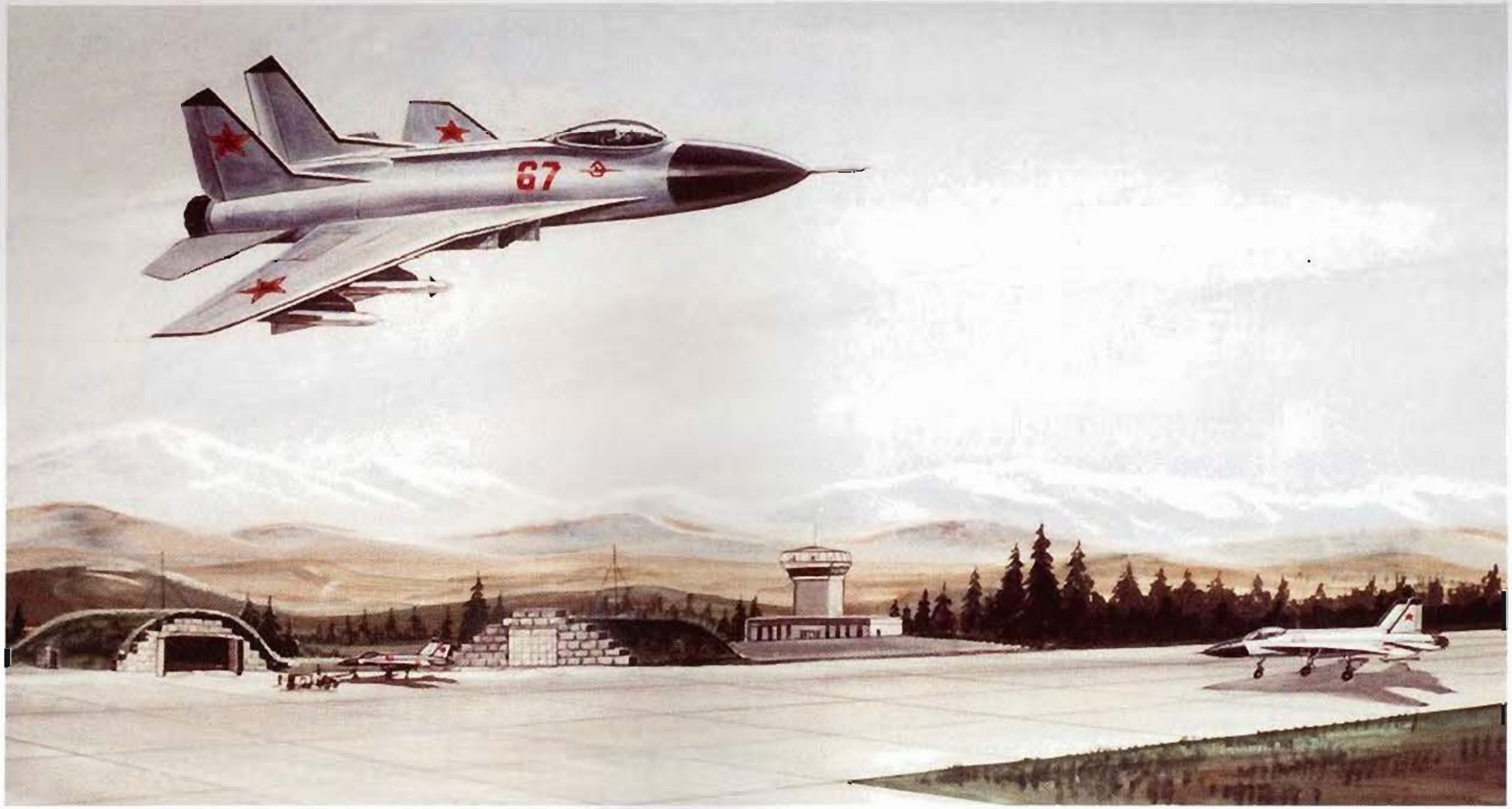
In 1975 the United States and NATO member countries began a Joint Service Operational Requirement for an Advanced Air-to-Air Tactical Missile that would be fielded from 1985 and which could engage aerial threats at anywhere between three and 40 miles. The missile would replace the venerable, if not revered, AIM-7 Sparrow.

The conceptual phase of development was completed in 1979, and the program phase was completed in 1981 when Hughes Aircraft Company's Missile Systems Group was awarded the contract to begin FSD. During FSD, Hughes Aircraft completed missile development and Raytheon was selected as an additional contractor by the time a production contact was awarded in 1987. More than 200 test missiles were launched during flight tests at Eglin AFB, White Sands Missile Range, and Point Mugu, by combined Developmental Test & Evaluation and Initial Operational Test & Evaluation programs. The missile that all these years of conceptualising, designing and testing produced, was the AIM-120A AMRAAM (Advanced Medium-Range Air-to-Air Missile).

Nicknamed "Slammer" by those who know it best, AMRAAM weighs around 340lb and uses an advanced solid-fuel rocket motor to achieve a speed of Mach 4 and a range in excess of 30 miles against head-on targets. In long-range engagements AMRAAM steers toward the target using inertial guidance, receiving updated target information via a dedicated data link from the launch aircraft as it does so. It then transitions to a self-guiding terminal mode when the target is within range of its own monopulse radar set. With its sophisticated avionics, high Mach speed, and excellent maneuverability as it closes to the final seconds of the intercept, AMRAAM's Pk (Probability of Kill) when fired from optimal range is said to be phenomenal. The kill occurs when an active-radar proximity fuse, or impact fuse, commands the detonation of the 40lb high-explosive warhead to destroy the target.

By 1987 the other NATO partners had dropped out of the program, leaving the US Air Force and Navy to pursue the missile alone. The Air Force had long recognized that AMRAAM offered superior performance in every respect to the AIM-7, but that its digital interface was incompatible with the Eagle's many analog systems.[1] What was more, the increased capability of the AIM-120 – its various modes of operation, its expanded WEZ, the fact that multiple AMRAAMs could be ripple fired against multiple bandits, etc. – meant that the Eagle would need more processing power than its existing CC could provide, as well as the prerequisite amount of memory in the CC to store the algorithms and data necessary to compute the missile's complex DLZ. The Eagle would also need to have its MUX updated if all of this information was to be expected to flow back-and-forth from computers to missiles and vice versa.

OPPOSITE
The small antenna ahead of the windshield belongs to improved ALQ-135B ICS, which gave the Eagle superior protection against a broader spectrum of threat emitters. Combined with the digital ALR-56C RWR, it conferred a superior operating capability in multiple, high-density threat environments. A second, identical antenna is located behind the radome, underneath the fuselage. (Steve Davies www.fjphotography.com)



ABOVE
They knew they were coming, they just didn't know exactly what they looked like! This 1984 depiction of the new Su-27 (bottom) and MiG-29 (inflight) showed two of the three major threats to the Eagle that MSIP and AMRAAM were designed to counter. By the time MSIP arrived in 1986, "Flanker" and "Fulcrum" had been in service for two and three years, respectively. (USAF, courtesy of Soviet Military Power)

Underpinning both AMRAAM and the need to update the Eagle, was the necessity to keep the Eagle as far ahead as possible of emerging Soviet jet fighters: to "provide maximum air superiority in a dense hostile environment in the late 1990s and beyond," as said one Eagle pilot involved with implementing MSIP. Also, Russia was producing fighters that, aside from the misinformation and secrecy surrounding them, looked very threatening indeed. Potentially the most capable of these in the interception role was the Sukhoi Su-27 "Flanker" which had undergone flight testing in various pre-production guises since 1977. Entering service in 1984, the "Flanker" was a big fighter that boasted a far-reaching radar, excellent interception performance in addition to superb dogfight maneuverability, and an excellent combat radius. Complementing it was the MiG-29 "Fulcrum" – born from the Soviet's knee-jerk reaction to the F-X program – which was a point-defense fighter that could seriously threaten the F-15 at the merge. Although it carried a smaller weapons load than the "Flanker" and had a limited combat radius, it promised breathtaking maneuverability. The "Fulcrum" had also been conducting pre-production test flights since 1977. It entered service in 1983. Finally, there was the MiG-31 "Foxhound," a two-seat dedicated interceptor that was essentially an outgrowth of the MiG-25 "Foxbat," and which was believed to feature a look-down radar, multi-target tracking capability and an improved performance envelope that gave it unmatchable speed

ABOVE
MSIP's extensive introduction of digital avionics and components saw the sun set on the Eagle's analog days. Priority was given to Active Duty F-15C/Ds, but F-15As, like this "Bayou Militia" jet, were also upgraded with what were essentially the same improvements. (Gary Klett via Steve Davies)

even at low altitude – its combat radius was vast, to boot. The "Foxhound" had first been flown in prototype form in 1975 and by 1979 production variants were being manufactured, it finally entered service in 1982. The Air Force later put it succinctly:

> The early 1970s technology of the aircraft in the inventory at the time did not provide either the efficacy or the adaptability required by the Tactical Air Forces to maintain air superiority in the future. Managers conceived a retrofit program as a solution that was at the same time practical and thrifty and that would ultimately extend the years of service of the F-15 fleet.[2]

That program was the Multi Stage Improvement Programme or MSIP.

MSIP

MSIP was conceived as a two-tiered program that would update both A/B-models and C/D-models. MSIP I would be used to upgrade the A/Bs through a fairly restrained depot-level retrofit. MSIP II was a more aggressive upgrade that would take place at depot-level for Eagles already in service, and would be built into new F-15C/Ds rolling out of their plant in St. Louis. Ultimately, the expense of having two separate MSIP modifications led to the demise of MSIP I, and MSIP II was thenceforth simply referred to as MSIP. Despite MSIP I being abandoned, F-15As and Bs still received MSIP.[3]

The improvement program focused on several key areas: the CC, the MUX and its associated cabling, a new armament control set, HOTAS improvements, and modifications to allow provision for the future addition of a Link 16 data link.

The MSIP modification kits contained nine aircraft kits with 29 separate kit configurations that included 48 sub-kits each, ten commodity class kits, and nine support equipment kits per upgraded airframe. MSIP installation took up to 10,000 man hours so, to save down-time and money, the modification was planned to coincide with the planned depot maintenance schedules of the Eagles already in service. Although 75 percent of Eagles were updated at the Warner-Robins Air Logistics Center (home of the USAF's F-15 PDM [planned depot maintenance]), sites at CASA Getafe, Spain; Israel Aircraft Industries, Israel; and Kim Hae, South Korea, were also involved in updating USAFE, IAF and JASDF Eagles, respectively. The modifications commenced in 1986 with 13 Eagles: F-15D 84-0002 was the first ever MSIP Eagle, followed closely by F-15C 84-0001 which was the first MSIP C-model off the production line.

The MUX was upgraded to include a faster, MIL-STD-1760 aircraft and weapons interface that supported the digital data transfer required by the AMRAAM. Supplementing this was a MIL-STD-1553 digital data bus that enabled the Eagle's remaining legacy systems to communicate with its newer digital systems. The MUX upgrade allowed the jet to take advantage of the Very High Speed Integrated Circuit CC (VHSIC CC). This new CC had significantly improved processing speed and memory capacity when compared to the CCs thus far installed in the Eagle. The original Eagle had less computer capacity than a 1990s' car, and the VHSIC would store four times more information, process data three times faster, and be 20 percent more reliable.

The main problem in the early 1980s was that the C-model's CC was still analog, necessitating MSIP to bring the CC into the digital world. Since the AMRAAM was a digital missile, and the APG-63 was now also utilising a digital architecture, the CC and the MUX and its cabling became the limiting factor in getting the radar's target information to the missile. The digital VHSIC CC could include all the AIM-120's many varied envelopes for its various modes (in addition to those of the AIM-7M and AIM-9M), and the 1760 MUX provided the bandwidth and data sharing technology to get it there. These two factors – memory size and speed of data transfer – required computing power way beyond what the earlier CC could provide. Dildy's excellent Star Wars analogy sums up the evolution perfectly:

> It was like getting R2-D2 to run the onboard systems while we *Luke Skywalkers* fought the *TIE fighters* in our X-Wings. First, we started with "R1-D1" (16KB) in the A-models – a stupid little robot; then we got the "expanded" "R1-D2" (24.6KB) for the late A-models; then "R2-D1" (34KB) for the early C-models; and finally R2-D2 – the MSIP mod-ed droid! – with the MSIP upgrade. Whatever its real Air Force nomenclature, it was always a droid. Radars arrive and go, as do other systems, sensors, displays, like bricks in a wall or patches on a quilt, but it is the computer that is the foundation and continuity to all this. This is why the airplane was designed to operate without a Weapons Systems Operator: a babbling C3-PO, if you think about it!

MSIP introduced a new programable armament control set (PACS) that was interfaced by a new multi-purpose colour display (MPCD) in the cockpit. The new display replaced the old analog armament panel, and gave expanded weapons control, monitoring, and release capabilities via push buttons arranged around the screen's frame. The MPCD also gave the pilot information on the status of the ICS – what mode it was in and whether it was jamming – as well as the quantity of chaff and flare remaining and which release mode they were in. The MPCD was also set to be the interface for a future upgrade that would see the introduction of the Joint Tactical Information Distribution System (JTIDS). While MSIP was unrelated to the integration of JTIDS, some of the work carried out during the mod prefaced it by creating internal space, uprating internal electrical power, and installing new cooling systems necessary to run it.

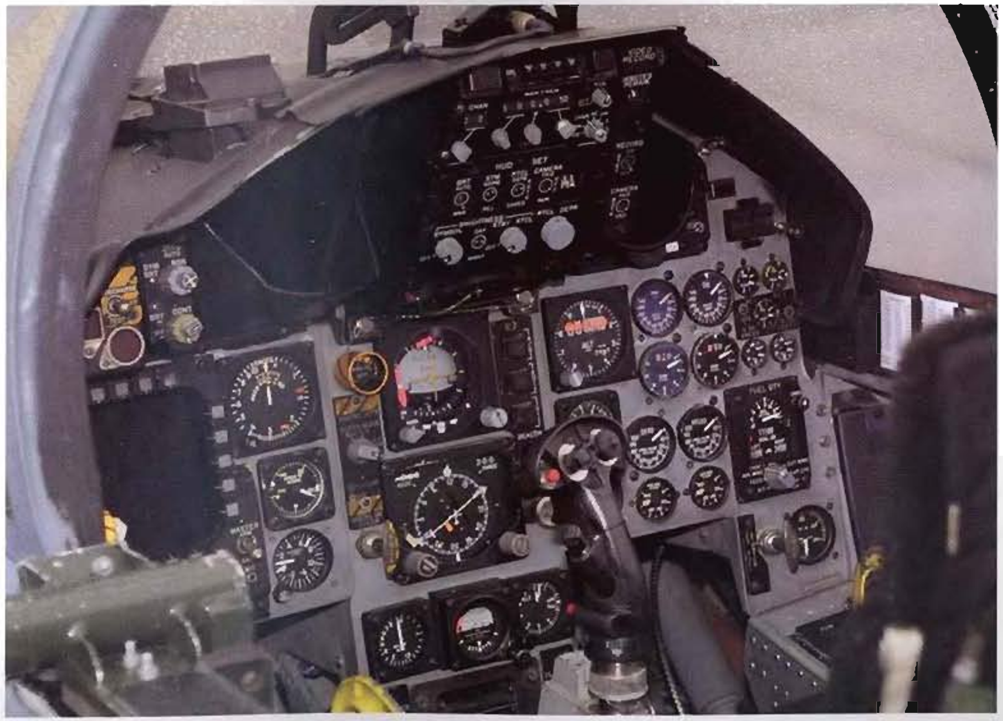
Also installed in the cockpit was the receptacle for the data transfer module (DTM). The DTM used a data transfer cartridge (DTC), or "brick," to store sortie information created by flight planning computers in the squadrons. Whereas historically pilots had to key steer point and navigation data into the jet's INS manually, the brick allowed them to transfer this data direct from the mission planning software to the waiting Eagle. The pilot simply saved the data at the computer to the DTC, walked out to the jet and then inserted it into the DTM receptacle at the appropriate time. This preprogrammed information then customized the jet to fly the route the pilot had created. In addition, the brick was used at the end of the flight to allow the CC to dump any relevant information for use by the maintainers. This included failures and over-g information.

The most significant transformation in the cockpit was the addition of a new stick grip and throttle quadrant. The stick came straight from the F-15E and gave the pilot two new multi-function switches (a four-way "castle turret"-shaped switch for the radar and TDC control, and a three-way, self-explanatory Auto Acq switch). The new throttles were more subtle in their change, featuring a new four-way "coolie hat" shaped multi-function switch and a two-way missile reject switch. The new coolie switch tied all of the AAI (air-to-air interrogator) and EID (electronic ID) functions of the jet into one switch, allowing the pilot to initiate combined interrogations on a target simultaneously by all three of the Eagle's EID systems (EWWS, AAI and NCTR), or to simply run the AAI and air-to-air TACAN (tactical air navigation) on it.

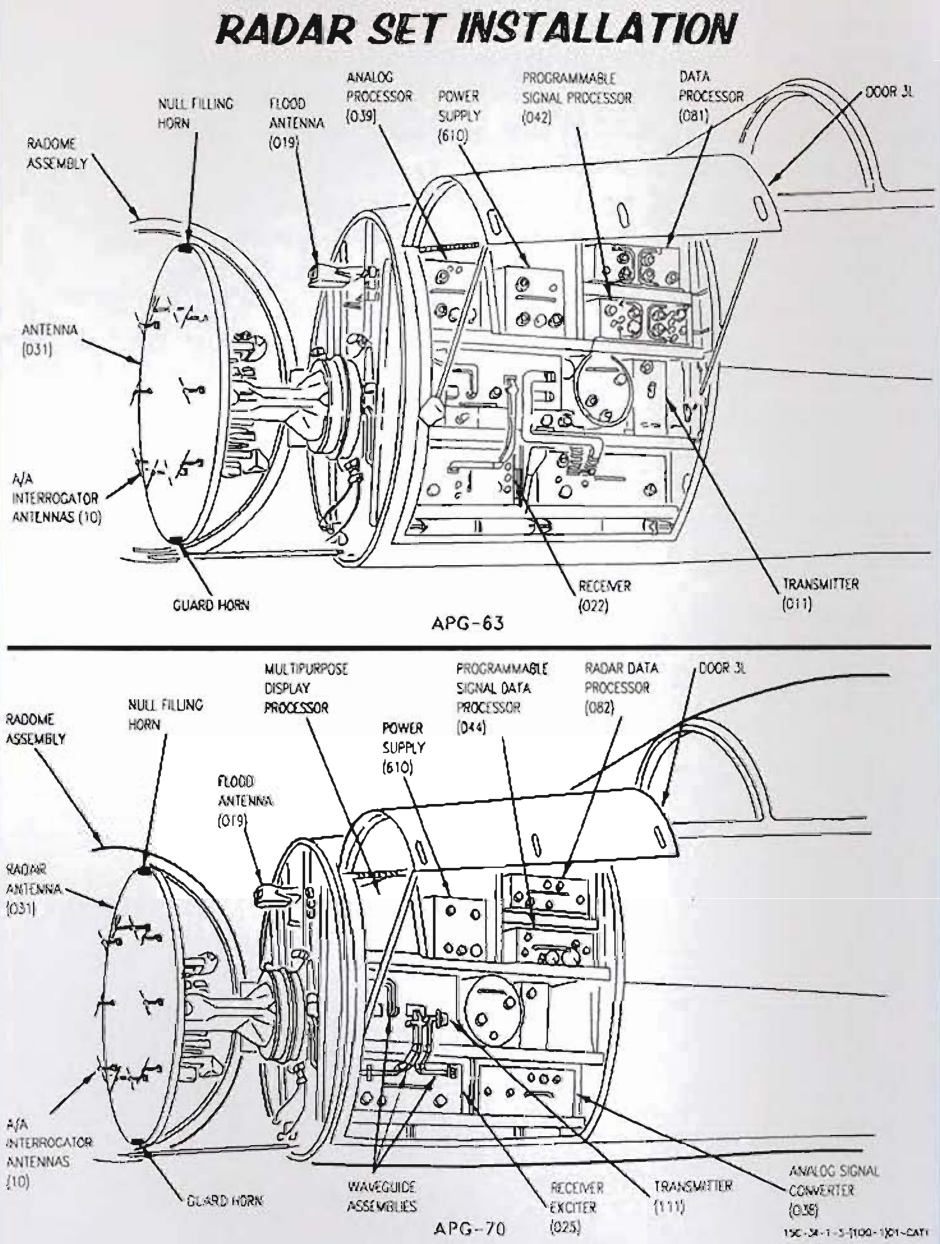
Non-Cooperative Target Recognition – NCTR, pronounced "nectar" – was a brand-new tool the pilot could use to acquire an EID on his target, and was an integral part of MSIP.’ It came as a direct result of the additional processing power made available by the VHSIC CC, and would in theory enable the pilot to identify and target the enemy aircraft before he was detected or before an enemy could employ his weapons. It did so through analysis of the radar returns emanating from the target's engine compressor and turbine blades. Each engine type returns radar echoes that are distinct enough to allow them to be categorized. The VHSIC CC does this by comparing them to an onboard library of radar echoes, and then providing a caption on the radar display to show what it thinks the target is.’ Thus, if the echoes matched those in the library associated with the Klimov RD-33 turbofan, NCTR would display a "MiG-29" caption on the VSD; but if the engine(s) matched the profile for the Lyulka AL-31F, then "Su-27" was displayed instead. Although the radar signatures of friendly aircraft are included into its library, occasionally there are ambiguities. Even so, it provided another layer to the EID matrix and would prove very useful during both Operation *Desert Storm* and Operation *Allied Force* in the years ahead.

The APG-63 itself received MSIP modifications in the form of a digital PSP (programable signal processor) to enhance its multiple target detection, ECCM characteristics. The ALR-56A RWR was replaced with a digital ALR-56C, which was better suited to operations in areas where there was a high saturation of threats, and where multiple threat types existed – the new model's digital architecture meant that it was less likely to become overwhelmed (and thus, slow and confused) when all hell broke loose.

Finally, the newest version of the ICS – the ALQ-135B – was installed, conferring enhanced threat detection and self-protection radar jamming capabilities. Externally, the new ICS added two additional tear drop-shape antennas to the nose (above and below) as well as a round rear-facing antenna on the starboard fuselage boom. From a capabilities perspective, the new ICS added greater coverage to the overlapping Band 1 (E to G frequencies) and Band 2 (G to I frequencies) coverage already provided. This meant that the Eagle's ICS would now cover the J frequency in which some adversary fighter radars and emerging SAMs operated.



RIGHT
The F-15C MSIP cockpit as pictured in 2004. Note the additional buttons on the stick grip. (Steve Davies: www.fjphotography.com)


RADAR SET INSTALLATION
RADOME ASSEMBLY
NULL FILLING HORN
FLOOD ANTENNA (019)
ANALOG PROCESSOR (039)
POWER SUPPLY (610)
PROGRAMMABLE SIGNAL PROCESSOR (042)
DATA PROCESSOR (081)
DOOR 3L
ANTENNA (031)
A/A INTERROGATOR ANTENNAS (10)
GUARD HORN
RECEIVER (022)
TRANSMITTER (011)
APG-63
MULTIPURPOSE DISPLAY PROCESSOR
PROGRAMMABLE SIGNAL DATA PROCESSOR (044)
RADAR DATA PROCESSOR (082)
DOOR 3L
RADOME ASSEMBLY
NULL FILLING HORN
POWER SUPPLY (610)
FLOOD ANTENNA (019)
RADAR ANTENNA (031)
A/A INTERROGATOR ANTENNAS (10)
GUARD HORN
WAVEGUIDE ASSEMBLIES
RECEIVER EXCITER (025)
TRANSMITTER (111)
ANALOG SIGNAL CONVERTER (035)
APG-70
15C-34-1-5-(100-1)01-CATI

LEFT
While 43 F-15Cs received the APG-70 as they rolled off the production line at McAir's St. Louis plant, the radar was never installed en masse into the Eagle fleet. The APG-70 used the same planar array antenna as the APG-63, but featured four new LRUs. Contrary to popular reports, the APG-70 was not an "upgraded" APG-63, but an altogether separate radar system that shared commonality with the Eagle's APG-63. (USAF)

APG-70

The APG-70 was an I/J-band (8-20GHz) radar that weighed 553lb and was designed around the APG-63 and APG-65, the latter of which was installed in the F-16 Viper. It had been in development since McAir and Hughes had first teamed up to build a strike version of the F-15, and the first flight with a partial APG-70 radar installed occurred on February 14, 1985. Hughes took the best features of all its radars and integrated them together to form the APG-70. It was not so much an "upgraded APG-63" as many called it, but a newer radar that featured commonality with the APG-63. The power supply was similar and the antenna was identical to the APG-63 (a high gain, low sidelobe planar array), but the other boxes were new to the APG-70 and incorporated new technology. Four new LRUs (referred to as "boxes") replaced five older ones. They were the power supply, radar data processor, radar signal processor, analog signal converter and receiver-exciter. A new power supply was necessary as one of the other boxes, the receiver-exciter, required a slightly higher voltage than before. The APG-70 was a coherent radar, which meant that its signal source remained running all the time; the amplifier was turned on and off to transmit a signal out of the antenna. The radar data processor was the brain of the radar, since it was the computer that controlled the radar. The radar signal processor was another computer which was optimized for data/signal processing.

The receiver-exciter featured 32 coherent channels of increased bandwidth, better tracking in ECCM environments, and increased sensitivity and detection capabilities. Signals received by the antenna were passed to the receiver, which converted them to a lower frequency and passed them on to the analog signal converter. This turned the signals into digital format, following which they were handed off to the signal processor. The new SP determined the "power levels" received by the antenna at a speed of over 30 million calculations per second. It was five times faster than the APG-63's SP and had ten times more memory. Using "modular parallel processing" via a MIL-STD-1750A central processor unit, the SP passed this information over to the RDP, another computer which operated five times faster, and which featured ten times more memory than the APG-63's (1,024K of memory – 220K air-to-air modes, 110K air-to-ground modes, 200k for the BIT feature, and the rest reserved for future upgrades). The RDP determined whether the signal was actually a target and then passed the information onto the radar MPD page. In total, computer processing was increased over previous radars. Hughes had built a radar that could detect targets with more efficiency and with radar modes that were subsequently enhanced as a result. New hardware circuitry also allowed Hughes to implement the High Resolution Mapping mode.

The APG-70 offered a 33 percent increase in reliability over the APG-63 and featured an 80-hour MTBF (mean time between failure) rate. Its BIT check had ten times the memory and six times the number of checks that the APG-63 had. These checks were characterized by unambiguous fault detection and isolation, allowing the system to narrow down closely which LRU was at fault.

There is a common belief that the installation of the APG-70 radar was part and parcel of MSIP, but we can find no official reference, or even anecdote from those pilots or maintainers involved with MSIP, to support this theory. Indeed, the facts speak for themselves: while the final 43 MSIP F-15Cs to be produced by McDonnell Douglas were equipped with the APG-70, neither were the first MSIP Eagles delivered to Eglin equipped with it, nor was it retrofitted to other MSIP jets. What is more likely is that McAir installed the new radar into the final 43 Eagles to allow the Air Force to develop the radar for the F-15E Strike Eagle. This had the additional benefit of helping the Air Force to hide the costs of the radar's development by putting the expense into the C-model's AF/DoD budget. In short, it was a sleight of hand move to get Congress to fund the Strike Eagle's radar without knowing it, ensuring that the F-15E would appear cheaper and that the Air Force was more likely to have it approved by Congress. The truth of the matter seems to be that MSIP was all about going digital and not about what piece of gear was behind the radome.

The new MSIP Eagles rolling off of the St. Louis production lines were sent to the 60th TFS at Eglin AFB's 33rd TFW.[6] Once the "Crows" had a full complement of MSIP jets, their sister squadrons, the 58th TFS and 59th TFS, were next in line. Some 323[7] F-15s had been retrospectively MSIP "modded," and 104 built, toward a total of 526 MSIP aircraft by the time the upgrade was completed in 1997.

DATALINKS, NAVIGATION AND COMMUNICATIONS, AND NEW MOTORS

Such was the multi-stage nature of the MSIP modification that additional components and systems were added further down the road. One such system was the inertial navigation system (INS).[8] This was originally a basic analog INS, but it was eventually superseded by a Litton LN-94 second-generation, ring laser gyro (RLG) INS. RLGs are inherently more accurate than previous gyros and the LN-94 provides better than 0.8nm/hr drift. Housed in the Inertial Sensor Assembly are three rate-integrating gyros, each of which consists of two contrarotating laser beams. The lasers are housed in a ceramic cavity (the ring laser), which is fitted with mirrors to reflect them. As the aircraft moves, the reflected laser energy changes frequency (when static, both lasers radiate at the same frequency). This shift in frequency is recorded and translated into aircraft velocity in all three axes by the inertial navigation digital computer. RLG INS makes more accurate velocity readings possible, and thus improves navigational performance.

The LN-94 features a Stored Heading fast alignment mode, which uses the INS coordinates from the previous flight to align in 30 seconds; a Gyro Compass mode, which uses parking data entered via the INS panel on the right console and requires four minutes of

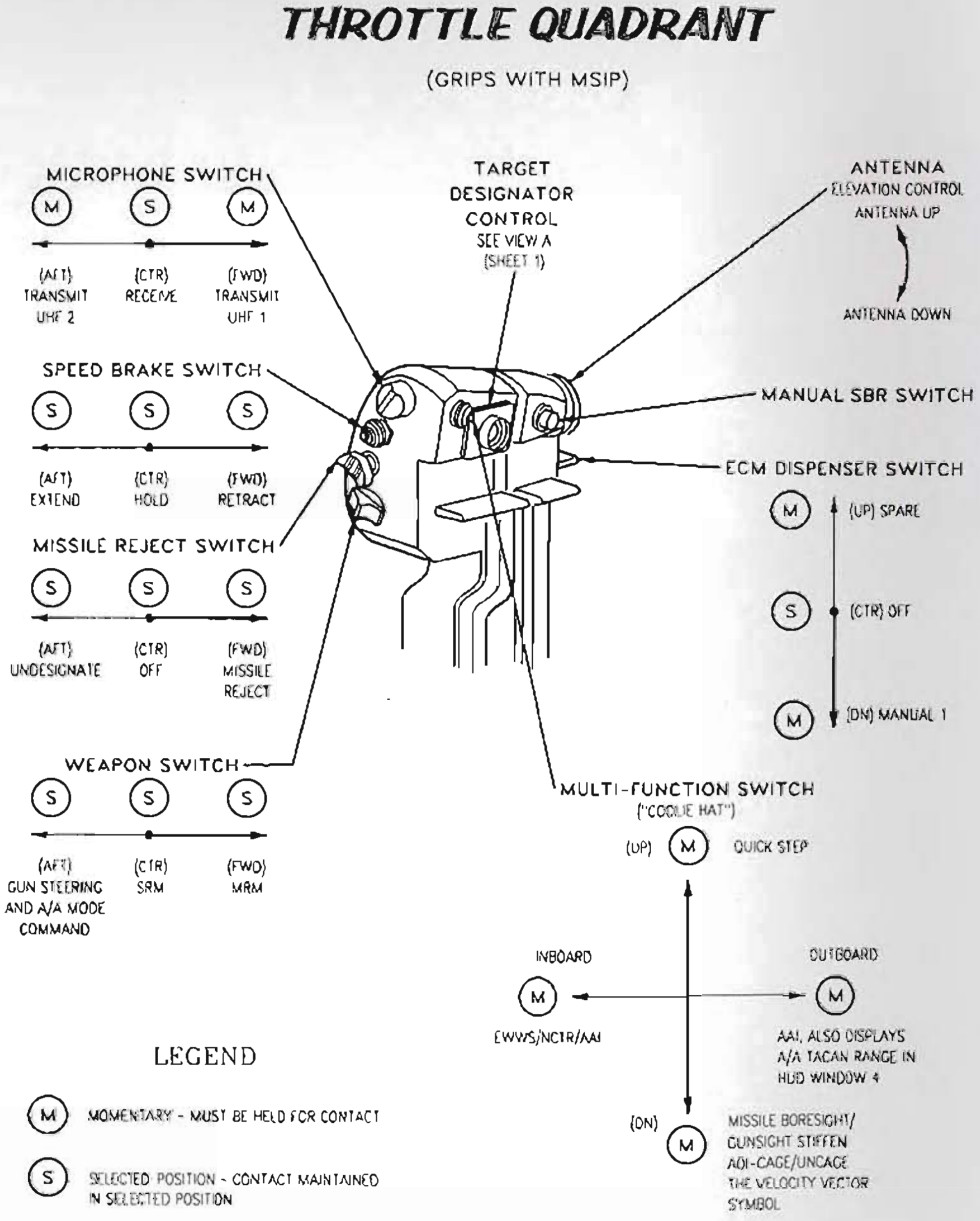
Maj Steve "Two Dogs" deMilliano
038

ABOVE
The 493rd FS, 48th FW at RAF Lakenheath is one of several squadrons equipped with the F100-PW-220 motor. Although it does not offer any additional thrust over the PW-100, it allows for carefree throttle movements, as well as providing reliability and maintenance gains (Steve Davies: www.fjphotography.com)

alignment time; and a "Nav" mode, which is the inflight flight mode and selected prior to take-off. One clever feature built into the GC mode is the ability to taxi after 60 seconds of alignment time, following which the INS will automatically continue to align if the airplane stops mid-taxi. Up to 12 steer points can be entered manually, or via the DTC.

OPPOSITE
The new DTM made life much simpler for the Eagle Driver. Whereas in the past he had to manually program all of the steer points for a given sortie each time he entered the cockpit, now he could allow a computer to take care of all of this. He simply took his DTC from mission planning, slapped it into the receptacle in the cockpit and then waited for the CC to extract all the data. Meanwhile, he got on with his other cockpit tasks. (Steve Davies: www.fjphotography.com)

Although not actually part of the MSIP mod, the JTIDS data link had been provided for by the mod, and while some examples of the system did find their way into ADC Eagles, it was never installed in Eagles en masse. JTIDS was a massive improvement over the basic data links utilized by ADC F-102s and F-106s of the likes that Granrud had flown before getting to the Eagle. It was a secure, jam-resistant, high-capacity data link communications system for use in a combat environment where multiple forms of jamming would be encountered. However, the single most important thing about JTIDS was its innovation. It took raw information from command and control systems and transformed it into a picture of the tactical arena displayed on the MPCD. This picture included the relative position of all known aircraft, and was "worth a thousand words." What this achieved was much improved situational awareness (SA), and a much reduced level of cognitive saturation on the part of the pilot. By October 1985 JTIDS was undergoing operational testing in the Eagle and was installed in some ADCTAC


THROTTLE QUADRANT
(GRIPS WITH MSIP)
MICROPHONE SWITCH
M
S
M
(AFT) TRANSMIT UHF 2
(CTR) RECEIVE
(FWD) TRANSMIT UHF 1
SPEED BRAKE SWITCH
S
S
S
(AFT) EXTEND
(CTR) HOLD
(FWD) RETRACT
MISSILE REJECT SWITCH
S
S
S
(AFT) UNDESIGNATE
(CTR) OFF
(FWD) MISSILE REJECT
WEAPON SWITCH
S
S
S
(AFT) GUN STEERING AND A/A MODE COMMAND
(CTR) SRM
(FWD) MRM
TARGET DESIGNATOR CONTROL
SEE VIEW A (SHEET 1)
ANTENNA ELEVATION CONTROL
ANTENNA UP
ANTENNA DOWN
MANUAL SBR SWITCH
ECM DISPENSER SWITCH
M
(UP) SPARE
S
(CTR) OFF
M
(DN) MANUAL 1
MULTI-FUNCTION SWITCH
("COOLIE HAT")
(UP)
M
QUICK STEP
INBOARD
M
EWWS/NCTR/AAI
OUTBOARD
M
AAI, ALSO DISPLAYS A/A TACAN RANGE IN HUD WINDOW 4
(DN)
M
MISSILE BORESIGHT/ GUNSIGHT STIFFEN AOI-CAGE/UNCAGE THE VELOCITY VECTOR SYMBOL
LEGEND
M
MOMENTARY - MUST BE HELD FOR CONTACT
S
SELECTED POSITION - CONTACT MAINTAINED IN SELECTED POSITION

ABOVE
Schematic of the MSIP throttle grips and button functionality. (USAF)

Operational Flight Program

The software that sits at the heart of the CC is upgraded as tweaks are made and new capabilities are added to the jet; this is known as the Operational Flight Program, or OFP for short. OFP also allows software upgrades to support new hardware installations, and the version of OFP in use on each jet will quickly allow a crew to determine what capabilities the aircraft has. OFP versions are typically characterized as "suites." OFP suites are common to the whole Eagle family, and an "E" suffix is given to those upgrades appropriate to the Strike Eagle (ie Suite 4E).[8] To save expenditure on operational testing, OFP suites are tested and developed by Boeing's OFP CTF at Eglin AFB, which is subsidized by the F-15 SPO at Wright-Patterson AFB, Ohio. The SPO is ultimately responsible for prioritising OFP improvements.

jets thereafter. Despite this, by 1989 US involvement in JTIDS was halted on grounds of cost in favor of developing more capable data links. From 1995 the USAF instead pursued the Fighter Data Link (FDL) multi information distribution system (MIDS) that would eventually equip all Eagles.

Installed in F-15Cs 85-0095 and up, and F-15Ds 85-0130 and up, was the new F100-PW-220 engine. The -220 was much anticipated and provided real improvements in operational capability, maintenance, fuel consumption and overall operating cost. The PW-220 actually produces slightly less thrust than the PW-100, developing 23,450lb of augmented thrust (380lb less compared to the PW-100). What makes the engine significantly more attractive, however, is the advantage of full authority digital electronic engine control (DEEC). DEEC has proven to reduce wear and tear on engine components while increasing engine performance, fuel consumption and life span. It achieves this through digital control laws that constantly monitor a range of operating parameters and makes fine tuned adjustments to them accordingly. DEEC replaced the PW-100's slower, analog system, which often "lags" behind the pilot's throttle inputs. Testing by the F-15 Combined Test Force commenced in the second quarter of 1985 and ran through until the beginning of the third quarter of 1986.

Beginning in 1997 an upgrade program commonly referred to as a "-220 equivalent kit," or simply "E-kit," began and is still ongoing today. This takes the F100-PW-100 engine and brings it up to the equivalent specification in thrust and reliability of a production model F100-PW-220 engine. In the upgrade process, the -100 engines are removed from the aircraft and overhauled at the Air Logistics Center at Tinker Air Force Base. During overhaul the engines receive upgraded parts and components via an E-kit supplied by P&W, thus becoming the equivalent of -220 production engines at less than half the cost of a new engine. It is a cost effective method of upgrading and from the mid-2000s the 33rd FW at Eglin AFB has been completing its PW-220E upgrades locally.

READY FOR WAR

With the F-15C fleet beginning to look more lethal than ever as the MSIP mod began to rollout, the timing could not have been better. Despite the fact that many of the changes MSIP brought to the Eagle would not be fully exploited until the AIM-120 AMRAAM reached IOC in September 1991, the Eagle was about to go to war. Its new digital avionics, its new NCTR EID capability, and its improved TEWS suite would play a crucial role in the success that would follow.

EG
034
EG
059
EG
58

11

WHEN EAGLES FLY, MIGS DIE!

OPERATION *DESERT SHIELD*

On August 2, 1990, Iraq acted upon its historical claim to the small oil-rich country of Kuwait. Its dictator, Saddam Hussein, had massed a large invasion force north of the Kuwaiti border, and Kuwait was unprepared for the blitzkrieg attack that followed. Iraqi armor and infantry, supported by helicopter gunships, entered Kuwait City against minimal resistance.

The international community's initial military response was defensive in nature and was christened Operation *Desert Shield*. In mid-January 1991 this defensive posture gave way to Operation *Desert Storm*. Where *Desert Shield* had allowed Coalition forces to amass while diplomacy took its course, *Desert Storm* was the US-led, Coalition effort that would expeditiously decimate the Iraqi invaders and rid Kuwait of its occupying forces.

At the center of it all was the F-15C, initially patrolling the skies and safeguarding the Coalition build-up, then later clearing the way for Coalition aircraft to operate with almost complete immunity from the Iraqi air force (IRAF).

F-15 DEPLOYMENTS AND ORDER OF BATTLE

The F-15 was the first aircraft mobilized when news of the Iraqi invasion reached President George Bush, Snr. The 1st TFW, Langley AFB, was immediately put on standby to rapidly deploy in a move intended to curb any attempts by Iraq to attack Saudi Arabia. A force of 24 F-15Cs and three F-15Ds from the 71st FS arrived fully armed at Dhahran, Saudi Arabia, on August 7, and, under the revised title of 1st TFW (P) (Provisional), 14th Air Division (P), it immediately began flying CAPs along the border between Saudi Arabia and Iraq. The next day, an additional 25 F-15C/Ds from the 27th TFS arrived, heralding the deployment of 52 1st TFW Eagles in just two days.

Another 24 F-15Cs and 36 pilots deployed later in August from the 58th TFS "Gorillas" (augmented by crews and aircraft from the 60th TFS), 33rd TFW, Eglin AFB, Florida. They were sent to King Faisal AB (a Saudi Arabia F-5 base also known as Tabuk) in the far northwestern corner of Saudi Arabia in an effort to spread the placement of Eagles along the border. "We flew as four six-ships non-stop from Eglin to Saudi Arabia, which is about 15.5 hours and seven air refuelings. We were quite a way from the Saudi border [although the closest F-15 unit to Baghdad], which was not ideal because we had to take off and fly for an hour before we even got to our tanker. Only then could we think about turning north and actually doing our mission. During the course of the war

OPPOSITE
Eglin's 58th TFS would end the war as the leading MiG-killer unit. It took a mix of MSIP and non-MSIP jets to Operation *Desert Shield*, but as time progressed the 33rd TFW replaced the non-MSIP Eagles with the modified jets prior to the commencement of hostilities. (Steve Davies: www.fjphotography.com)

we routinely flew 10-hour+ missions as a consequence of that," recalled Col Larry Pitts.[1]

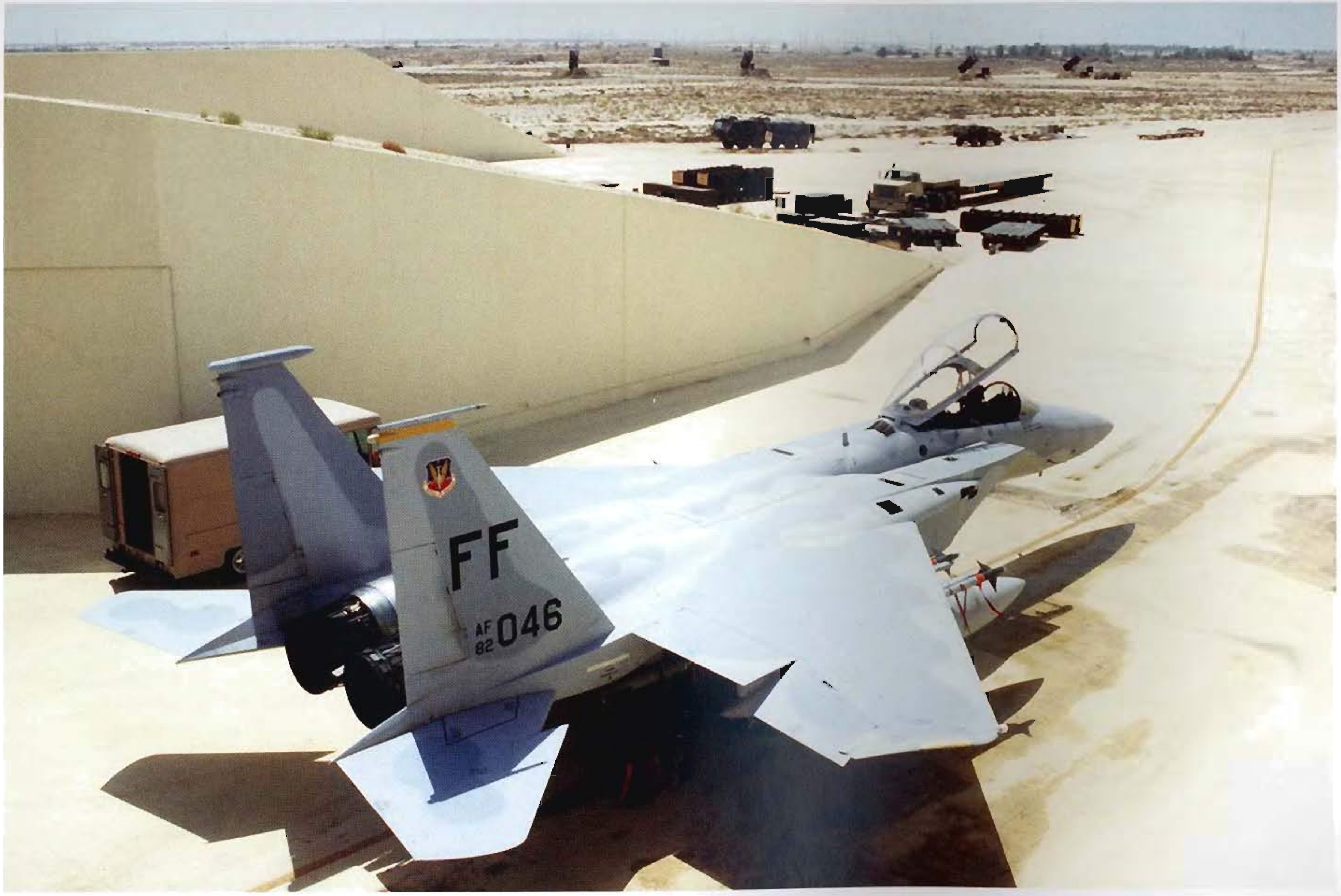
The 36th TFW at Bitburg AB, Germany, was earmarked to send its 24 53rd TFS MSIP F-15Cs – under the operational control of the 14th AD (Provisional), Central Command – to Prince Sultan AB, Saudi Arabia. Col Jay Denney recalled:

> We 53rd TFS knew we were on tap to deploy from October [1990], but we were up at Soesterberg AB on the *William Tell* competition team [an annual USAF air-to-air competition] on August 2. Eglin and Langley both deployed and on August 6 we were told to go home to get ready to go. We eventually arrived at Prince Sultan AB on the December 20 and started flying CAP right away.[2]

Not wishing to appear superfluous to requirements, USAFE managed to convince supreme Coalition commander General Schwarzkopf, that it should also send F-15Cs to the region to assist under its own command. Schwarzkopf conceded, allowing another Bitburg squadron, the 525th TFS "Bulldogs," to deploy ten F-15Cs – a single aircraft from each of the 22nd TFS and 32nd TFS at Soesterberg was borrowed by the 525th TFS in order to help make up the numbers – under USAFE control, to Incirlik AB. The 525th TFS was to patrol Iraq's northern territories, but only on the condition that it did not interfere with the plans Schwarzkopf had already laid down for the air war.

An additional four "Bulldog" F-15Cs plus six Eagles and ten pilots from the 32nd TFS "Wolfhounds," Soesterberg AB, Netherlands,

BELOW
On January 28, Capt Donald "Muddy" Watrous downed an Iraqi MiG-23 that was attempting to flee to Iran. Watrous destroyed the "Flogger" with an AIM-7 while flying F-15C 79-0022. The Eagle, like many of those that scored kills in ODS, carries a discrete kill marking to this day. (Gary Klett via Steve Davies)



joined the Incirlik-based 525th TFS, arriving on the first day of the war – January 17, 1991. Together the 20 jets and 30 pilots formed the equivalent of one fighter squadron and were known as the "War Dogs."

ABOVE
The "illustrious" 1st TFW deployed to Prince Sultan AB, Saudi Arabia, on August 7. This 71st TFS D-model sits outside one of PSAB's ultra-modern shelters, armed with four live AIM-9L Sidewinders and four AIM-7M Sparrows. The "tub" jets were not used in combat, but were relied upon for local area familiarisation and continuation training sorties. (USAF)

ABOVE
The MiG-29 "Fulcrum" was the chief cause of concern to the Eagle pilots tasked with securing air superiority over Iraq. In the visual arena, the "Fulcrum" was smaller than the Eagle and extremely agile, and was similarly configured with twin vertical tails and twin engines, making VID problematic except at fairly close range. (USAF)

IRAF ORDER OF BATTLE

On paper, the Iraqi air threat was portentous. Saddam Hussein had invested in his *Al Quwwat al Jawwiya al Iraqiya* (Iraqi air force) extensively. It comprised a mixed array of aircraft capable of fighting for air supremacy, repelling ground assaults and attacking strategic targets. Aircraft were assigned to five major IRAF commands: the Army-controlled Aviation Corps; Training Command; Transport Command; Air Defense Command (ADC) and Air Support Command (ASC).

The last mentioned was the IRAF's tactical air command providing interdiction, battlefield reconnaissance, maritime strike and close air support for army units in combat. The ASC's most potent long range striking force was a mixed bomber brigade made up of three Tu-22 "Blinder" squadrons, two Su-24MK "Fencer" squadrons and a Tu-16/H-6D "Badger" squadron, the latter of which was transitioning to the higher-performance "Blinder." The "Fencer" was the most respected air-to-ground machine in the IRAF inventory. Being similar in configuration to the F-111, it had the capacity to mount devastating attacks against ground and sea targets. For battlefield interdiction and ground support for troops in contact, the ASC also maintained ten brigades equipped with Su-20/22 "Fitters" and MiG-23BN/BK/MS air-to-ground "Floggers." Because of high attrition suffered by these units in the Iran-Iraq War, all were under-strength and incapable of attaining anything like the sortie generation rates of Coalition squadrons.

The ASC also included a portion of the 40 or so Mirage F1EQs which remained (of 118 purchased), plus 15 two-seat F1BQs, and 20 F1CKs captured in the invasion of Kuwait. The IRAF had a total of eight Mirage squadrons, each of them equipped with no more than seven examples and many of those unflyable. For the Iraqis the F1EQ had proved a very suitable multi-role fighter-bomber, restricted only by the limited amounts of ordnance that could be carried. Nevertheless, it was able to carry a wide variety, from "iron bombs" for use against troops and tanks to AM-39 Exocet anti-shipping missiles, making it a threat in all arenas. As an air-to-air fighter, the F1EQ was considered a potential BVR threat because, unlike the Soviets who provided BVR-capable MiGs of several types without their BVR missiles, the Mirage had been sold to the Iraqis by the French complete with its Matra 530D radar-guided missiles. Although several of these small squadrons were assigned to the Air Support Command, given the IRAF's initial defensive posture, all were allocated to the Air Defense Command for use in blunting the anticipated initial, heavy Coalition air assault.

In addition to the Mirage squadrons, the Air Defense Command had five brigades of Soviet-supplied fighters: a large number of MiG-21 "Fishbeds," 22 MiG-23ML and 55 MiG-23MS/MF air-to-air "Floggers," 22 MiG-25PD (export) "Foxbats," and 35 of the formidable MiG-29 "Fulcrums."[1] The highest performing of these was the "Foxbat" which operated as part of a composite interceptor-recce brigade, with four squadrons of MiG-25PD interceptors and MiG-25RB reconnaissance platforms. Because of its superior performance, the MiG-25PD posed a considerable threat to all Coalition aircraft, but especially against high-value asset (HVA) platforms such as AWACS, Rivet Joint, J-STARS and tankers.

The Soviet-supplied MiG-29s were believed to not have been provided with the R-27R/AA-10 "Alamo" radar missile, or the advanced, high off-boresight and highly maneuverable R-73/AA-11 "Archer" IR-missile, but this could not be counted on by the USAF fighter squadrons. Additionally the NO-193 "Slot Back" radar was significantly downgraded from those in Soviet or Warsaw Pact air arms and proved very poor in the look-down/shoot-down scenario. Thus, as with NVN pilots decades before, Iraqi pilots required GCI vectors to close with incoming adversaries. However, even without the BVR capability, the "Fulcrum's" excellent maneuverability, very agile short-range R-60/AA-8 "Aphid" IR missile and GSh-301 30mm gun made it an excellent point defense interceptor that would have to be swept away from the Coalition's high-priority targets so that the strikers could get in and begin to dismantle and destroy the IRAF's IADS.

The IRAF Air Defense Command was distributed across four Sector Commands, each of which was linked to an extensive GCI and IADS, the central control network that would orchestrate and control the Iraqi pilots in accordance with the Soviet doctrine in which they had been schooled. Despite superior training, tactics and equipment, the USAF conservatively held the view that it would probably lose a number of F-15s to Iraqi fighters for the simple reason that IRAF pilots had seen extensive combat action in the Iran-Iraq War. In contrast to the seasoned ranks of the Iraqi air force, few pilots among the Eagle squadrons had seen combat before.

THE FRAG AND OPERATION *DESERT STORM*

On January 17, 1991, the order to execute the first strikes was given by President Bush – Operation *Desert Storm* had begun. The Air Tasking Order (ATO), which was referred to as the "frag" (fragmentary order) and was basically the roadmap that charted each and every planned sortie, focused initially on killing the IADS that protected Iraq, and on taking out airfields, HASs and aircraft. With this achieved, Iraqi armor, C3 (Command, Control & Communications) and logistics supplies could then be struck, leading to the rapid weakening of the enemy prior to a Coalition ground assault.

The first three days of the frag were as scripted as possible, with changes occurring only to accommodate a fickle weather system that could generate generous blankets of cloud cover for days on end. The original ATO (as drafted soon after the 1st FW deployed) saw all F-15Cs providing escort and CAP from the south, but the decision to deploy USAFE F-15s to Turkey allowed planners to sandwich the IRAF by attacking it from the north as well.

The three F-15 wings organized themselves in different ways. The 58th TFS favored a "hard crew" approach that assigned a cadre of 12 pilots (three four-ships) to the offensive counter air (OCA) mission for the first ten days of the war, while the rest of the squadron's pilots performed defensive counter air (DCA) and HVACAP missions. HVACAP and DCA were typically about protecting tankers, AWACS and reconnaissance assets which were orbiting south of the Saudi Arabia–Iraq border. OCA was, by contrast, an offensive mission that saw the F-15 push deep into Iraqi airspace. The "Gorillas," as the 58th TFS was called, had a surplus of Fighter Weapons School graduates among its ranks and was one of the best-trained F-15 units in the Air Force, having participated in the 1989 and 1990 *Red Flag* exercises that trained pilots for war. Rick Tollini, who led the first F-15C sweep into Iraq, commented that the Squadron had also worked extensively with the secretive 422nd Test & Evaluation Squadron to develop high-level tactics.

Rather than assigning pilots according to mission category, the two 1st TFW squadrons and the 53rd TFS adopted a night/day shift pattern that split the aircrew into two teams for the entire war. This offered the advantage that the night team could plan the next day mission while the day team slept, and vice versa. In the events that unfolded that first night the USAF scored six kills against the Iraqi air force, all at the hands of the F-15C.

BELOW
The "BT" tailcodes give this jet away as a 53rd TFS bird from Bitburg AB, West Germany. The Squadron deployed for *Desert Storm* and adopted a night/day shift pattern with the 71st TFS from Langley. The "Tigers" would return to Bitburg with 11 kills to their credit. (USAF)

FIRST KILL

Day One of the ATO called for F-15s from Bitburg, Langley and Eglin to patrol discrete areas of responsibility as defined by lines of longitude or recognizable geographical features. Col Jon "JB" Kelk recalled:

> There were eight F-15s from the 58th TFS at Tabuk assigned to patrol the western sector of Iraq; Bitburg's 53rd TFS at PSAB was supplying eight airframes to patrol the central zone, and the 1st FW at Dhahran was supplying four aircraft to cover the very east of Iraq. We planned to march up the center of our area and clean out the Iraqi air force. If you take Baghdad and separate it into east and west, then we were taking the west sector, with particular attention given to the Iraqi airfields, H1, H2, Mudaysis, Al Assad and Al Taqaddum. Our job was to dispense with the air threat along that path while the Langley and Bitburg guys cleared the air east of Baghdad.'

In the early hours of January 17, 1991, the 58th TFS launched two flights of four F-15Cs, callsigns CITGO 61-64 and PENNZOIL 61-64.

Capt Bruce Shipp

ABOVE
Prewar computer simulations had predicted significant Coalition losses in the first 24 hours of the war. Although the Eagle Drivers knew that they were the best anywhere in the world, the grim reality of the situation was that Iraq's air force was not only large, but also manned by seasoned combat veterans whose recent experience fighting Iran seemed a valuable advantage. (USAF)

> I was the No. 3 guy in PENNZOIL flight, with Rick Tollini at No. 1, flight lead. We were a paired four-ship and the plan was that we would alternate the lead role every other night, so he would lead tonight and I would lead the next mission – both of us were FWS graduates, so it made sense to alternate the responsibility. At No. 2 was Larry Pitts and my No. 4 was Mark Williams.

The broad plan was to use F-117s and F-15E Strike Eagles to make a surprise attack at 03:00 local.

> This was to take place over Baghdad and over H2 and H3 airfields, where the Strike Eagles would engage in "Scud" hunting activities at low level, undetected. As they egressed, we were to take our aircraft and shoot down all the bad guys – a wall of our eight F-15s to mow down whoever took off from an Iraqi airfield. So, you had the surprise attack, then us, then a follow-on attack consisting of everyone else.

Despite the plan's simplicity, it quickly came apart. Notwithstanding horrendous weather conditions that presented some of the toughest air-to-air refueling conditions the men had ever experienced – towering cumulonimbus up to 30,000ft on a pitch-black, turbulent night and without any external lights – the IRAF learned of the F-15Es' "surprise attack" through some rudimentary intelligence assets:

> The problem was that there were listening posts along the border – physical listening posts where guys listened for the sound of aircraft – and a flight of 18 F-15Es makes a lot of noise.
>
> Shooting down one of your friends is a mortifying thought, and, even though we had our own means of identifying a contact and AWACS was there to help, it's a much better plan to keep friendlies and hostiles apart. The key component to the plan, therefore, was to let the F-117s and F-15Es clear out of the area. That way, when we went north into Iraq we knew that anything in front of us was an enemy. However, at around 03:05, AWACS calls that it has detected Iraqis flying, which is a problem because we are marshalling 50 miles to the south of the Saudi-Iraq border and CITGO flight – which planned to marshal up with us before the push towards Iraq – was about 100 miles behind us. We should have had plenty more time, but as soon as AWACS called PENNZOIL flight pushed north regardless.

When the call came to push, Kelk was less than pleased at the prospect of friendlies and enemies together. "I was thinking to myself, 'So much for that great eight-ship wall!' But we had no choice but to deal with the hand we were dealt. We got our formation set at our assigned altitude 30,000ft and headed north." CITGO flight was south of PENNZOIL because its lead, Rob Graeter, had decided to fly south of the poor weather. PENNZOIL, which cycled onto the tanker as CITGO departed to the south, may well have followed suit had the call not come from AWACS to push early.

As the PENNZOIL two-ships turned north the weather began to clear considerably. The flight assumed a lateral separation of around 5 miles, with each wingman laterally displaced from his lead by another 2 miles. This 9-mile wall formation was about to initiate the first contact of the war with the IRAF. From left to right were Pitts, Tollini, Kelk and Williams.

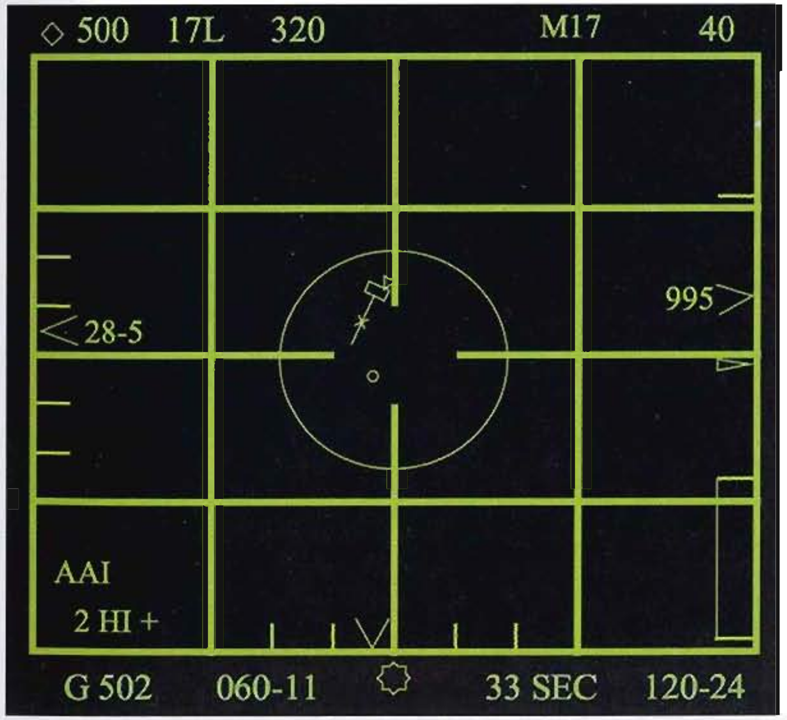
PENNZOIL was directed by AWACS to engage two groups of bandits located north east of Radif al Khafi Highway Strip and southeast of Mudaysis AB. Tollini and Pitts angled off to engage the western group, while Kelk and Williams were "snapped" – given short notice radar vectors by AWACS – to the eastern group. Larry Pitts, flying as Tollini's wingman on the far left of the formation, recalled that their worst nightmare had materialized:

> When I hit the IFF button to try and ID the guys out in front of me I had 40 or 50 friendly returns come up on the radar scope. I chased down a single contact because it threatened a strike package, but he ran and eventually landed. Had I got into weapons firing parameters though, I'd have really had a hard time deciding whether to shoot – we really did not want to kill a friendly.

Some 50 miles into Iraq, Kelk picked up the enemy contacts on his own radar:

> I got a spike radar warning indication that someone had locked onto me at about the same time as I locked onto him. Our formation was now No. 1 and No. 2 in the west, No. 3 and No. 4 in the east. My contact range was about 35 miles and, to my knowledge, there was just the one

BELOW
This radar screen shows a single target with the radar locked onto it and a missile in flight. When Pitts, Kelk's wingman, pressed the IFF interrogate switch on his throttle, the entire display filled with 50 or more friendly returns! (USAF via Steve Davies)



> guy out in front. As I press the attack, Williams is staying in radar sweep to check for other contacts. We had a thing called a Mode 4 rollover, where all the encrypted Mode 4 IFF codes changed right at 03:00 in the morning. But what if a guy is doing other things then? What if he's trying to evade, is dropping bombs, forgets to change the code or move the switch? I don't want to shoot down a guy just because he forgot to flick a switch, so I want to get an additional confirmation from AWACS.
>
> There was so much going on that the call is never completed and I have to use my own onboard systems to determine that he is not friendly. The bandit climbs from about 7,000 to 17,000 and is clearly maneuvering in relation to me when I eventually take the shot. I'm in an advantageous position at 30,000 because I can increase the range of my weapons against the lower-flying MiG.

As Kelk closed on his target, Tollini and Pitts saw their group turn away and depart the area, allowing them to head back east in support of Kelk and Williams. As they made the right turn, Tollini was also spiked momentarily by the lone MiG.

As Kelk and the bandit hurtled toward each other at a combined speed of more than 1,400mph, he closed his eyes to protect his night vision and pressed the pickle button on his control stick, unleashing one of his four AIM-7M Sparrow air-to-air missiles. Simultaneously he wrenched his F-15C into a high-*g* turn and enthusiastically mashed a button on his throttle to release chaff.

> I fired the missile from high-altitude and at above the Mach, which gave me a decided advantage. I distinctly remember feeling the missile coming off – a 500lb missile leaving the airplane is somewhat hard to miss – yet inside the cockpit, on the armament status panel, I have an indication saying that all four missiles are still remaining. I knew what I'd felt even though there were now conflicting cockpit cues, so I knew that it had come off.
>
> After I shoot I start dropping chaff, flying defensive maneuvers in case he's shooting at me. I also want to get down low to cause him some

GULF SPIRIT
1
1
3 8

RIGHT
The 33rd TFW's flagship was christened GULF SPIRIT after the Gulf of Mexico. The 58th TFS embodied that spirit and did very well during Operation *Desert Storm* for a number of reasons: leadership, the vast experience and talent of its pilots, recent experience training with aggressors in the US, and just a little bit of luck. (USAF)

> look-down shoot-down problems – it's time to get lower and maneuver away. In this case the chaff and maneuvering breaks his lock, and, with the spike gone, I turn in and point at the guy. I then see him blow up at co-altitude [the same altitude and, in this case, approximately 10 miles away]. It was nothing like the red glowing fireballs that you hear about, it was a bright purplish-white color that lasted three or five seconds. Then it was dark again.

The MiG-29 pilot went down with his aircraft and was killed. He is believed to have been Capt Omar Goben, who had previously flown the MiG-21 and MiG-23 and had two confirmed Iranian F-5 kills.

During the engagement Kelk had maneuverd defensively to the west, but Williams had maneuverd to the east,[5] separating them by some distance. To complicate matters, Tollini's reactions to his own spike had prompted him to also maneuver to the east – putting him on a potential collision course with Kelk to his right. As if that were not enough, in the confusion that followed Tollini locked up Williams and began the process of identifying him, uncertain of whether he was Kelk's original target! He was not sure of the ID and held his fire. Instead, he made a night visual ID as Willy passed, "very close, directly underneath me: I could recognize the cockpit lighting of an F-15C."[6]

Williams had also flown a defensive maneuver because he had been spiked by the same MiG Kelk had just downed:

> But we stuck to the game plan and flew our assigned flow. I was a little concerned because I had ordered that external tanks be jettisoned after the engagement, but my jettison had failed and I was carrying this extra weight around that I did not want. I am trying to keep up and build up speed without using afterburner and I'm playing catch-up with Williams, trying to rejoin without giving away my position [afterburner is highly visible at night]. We continued north toward Baghdad and, when I was no longer spiked, I did a radar sanitization and did not find anyone else in front of me. I eventually rejoined with Williams based on timings and pre-assigned headings and altitudes – I asked him to give me a quick flash of his beacons lights and I saw him about 1.5 miles ahead of me. We got to about 30 to 40 miles south of Baghdad and then commenced a left turn to the west to clear out the H1 and H2 airfields. We did not see anyone, so we flowed to the south and across the border again. I had one unnerving spike as we headed southbound. It was at my six o'clock close, and lasted about 5 seconds before it went away. I never saw it again.

Kelk's kill was verified the next morning by Intelligence as a MiG-29 "Fulcrum." He was the first American to score a kill in the F-15.[7]

THE FIRST DOUBLE KILL

With PENNZOIL flight approximately 100 miles ahead to the northeast and committed to intercepting the two groups of bogeys called out by AWACS, CITGO pushed northwest toward Mudaysis, a small air base used by forward-deployed IRAF fighters with an alert component of Mirage F1EQs.

Capt Robert "Cheese" Graeter was leading the flight:

> My No. 2 was Lt Scott Maw, No. 3 was LtCol Bill Thiel and No. 4 was Lt Robert Brooks. The initial push was totally screwed up: I was the first four-ship to hit the tanker, and getting gas was probably the scariest part of the whole mission. There were six KC-135s up there in the weather and we had to find our tanker by coming in laterally without using the radio, 500 vertical separation, no lights and using Mode 2 IFF. It took twice as long as usual to get our gas – it was bumpy; we were in and out of weather; and there was no moon.

PENNZOIL rolled up behind CITGO and awaited its turn on the tanker. Tollini later told Graeter that he had been so spatially disorientated while following him and the KC-135, that he could have sworn on the Bible that they were doing barrel rolls as they took on fuel. The conditions were so severe that Graeter checked the time, did some mental calculations and then decided to take his flight south, out of the weather.

> My wingmen had been on the wing in the weather for a better part of an hour. I wanted them to take a breath and relax for a little, because the weather, formation and tanking really was a handful. I sent them out to trail formation to let the radar work for them for a little while.

Nearing the push time, he gathered them in closer once again.

> I'd done all of the timing calculations, so as we approached we began to leave our holding area to hit our push-point at 03:10. AWACS started having concerns right on 03:00 and called us to commit early, which is why we ended up in trail to 'Kluso's' PENNZOIL flight. It takes almost 12 minutes to get to a stage where we can think about being tactical. As I climb the flight above a cirrus cloud deck, we get some star light and I am working the radar trying to find Kluso, which I eventually do.

Interestingly, Graeter chose not to fly a wall formation that evening. The relative merits of that formation – namely, its ability to bring maximum firepower and radar coverage to bear – were outweighed, in his opinion, by the workload it induced on his wingmen. Maw and Brooks were young pilots who were new to the jet. Graeter felt that the wall was an additional burden that he did not want to place upon his young wingmen. Instead, he chose a more orthodox night-time formation:

> Maw is to my right at about 40 degrees, LtCol Thiel is staggered back to about 15 miles in an offset trail to my left, with Brooks to his left. The formation provides us with some nose-tail separation so that we can maneuver without worrying about bumping into one another.

CITGO was tasked to run directly at Mudaysis, then to turn northwest towards H2 and H3. Once there, Graeter was to set up a Barrier CAP of two 25-mile legs between H2/H3 and Mudaysis, with a pair of Eagles on each leg. This would allow them to commit against IRAF fighters ascending from either base.

> As we run towards Mudaysis I can see all of the F-15Es [on Mode 4 IFF]. We see a CAP of MiG-29s 50 to 60 miles northwest of Mudaysis and about 85 miles from us, but they are all we can see. I'm pretty confident that the MiG-29s I can see are the same ones that AWACS is talking about because I am not getting a Mode 4 response from them. We're closing the distance on them, but we're not really running an intercept on them just yet.

As CITGO closed the gap, Graeter began to pick up new contacts over the top of Mudaysis.

> I get a contact at low altitude, which is my search area of responsibility; I have my radar set to search from ground level upward at about 18 miles in front of me; Maw has the opposite area and is looking from 50,000 and downward. At 25 miles my first contact appears to be at 4,000 – about 1,500 above ground level – and he's on a departure heading, going northwest. He starts a left-hand turn to the southeast so I break the lock and observe additional guys taking off. I see three contacts, all in a few miles trail.

Maw and Graeter melded their radars and sorted their targets in order to execute a coordinated plan of attack. At 17 miles Graeter locked the lead target and Maw concentrated on the trailer.

> I still have no idea what type of threat they are, but AWACS is getting information from Rivet Joint and is calling pop-up threats, which means that there are hostiles within 25 miles. I learn later from listening to the tapes that he's also referring to them as bandits, although I don't

BELOW

Capt Rick "Kluso" Tollini sits in the alert shack awaiting the order to scramble. The Game Boy and smorgasbord of snacks cluttering the table in front of him helped while away the mind-numbing hours. (Rick Tollini via Steve Davies)

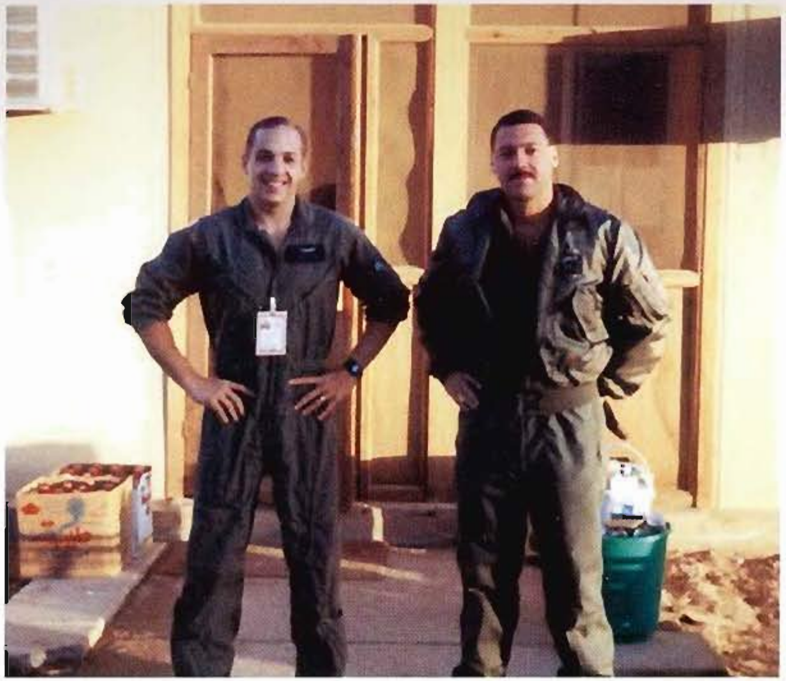
> hear that at the time. I'm therefore doing my NCTR and IFF EID [tree matrix], manually dialing in my Mode 3 7600 IFF code to see if anyone's squawking a comm failure, but getting no return. In the meantime I'm having to ramp it downhill from 30,000ft to the mid-20s because my radar look-angle is getting a bit steep. I finally finish my EID matrix at about 10 miles or so, but I'm still asking AWACS for confirmation of this guy [Graeter never heard the original AWACS call confirming that the target was a bandit], I get no response so I go ahead and shoot him at 10 miles.

In contrast to Kelk, Graeter watched his AIM-7 come off of the right side of the jet despite telling himself that he would not.

> Our game plan was to shoot and look to see if the rocket motor had fired and to check that the missile was looking good to intercept. So, that's what I did. I go back into the cockpit and fly my F-pole offset maneuver and execute a 40-degree check turn to the left to give the missile and me some added space. By the time I look back outside I can no longer see the missile, and, as the computer tells me that the missile is about to time out, I start to pull my nose back toward the target. That's when the missile goes off.
>
> I remember distinctly the missile exploding in a conical shape as the charge goes off. Everything coming off of it is red-hot, so it's easy for me to see this cone of energy. Instantaneously, at four or so miles from me and around 7,000, debris starts coming from the other direction – southeast – as the target explodes with a really bright flash. Pieces of it continue southeast in an arc of flame. I call, "Splash," and Maw confirms he can see it.

Maw was still locked to the trail Mirage some 14 or 15 miles ahead of him. No. 3 and No. 4, who had fallen back into a 20-mile trail, had already been dispatched to the northwest by

LEFT
F-15s in ODS nearly always carried three "bags" to war. At a predetermined range in an engagement the call to jettison would be made, and all three bags would tumble away. With the killing complete, the Eagles ran the gauntlet of finding a tanker before their internal tanks ran dry while simultaneously being locked up by RSAF F-15 Eagle CAPs. Almost out of gas, one Eagle driver told AWACS that if the Saudi Eagles did not stop locking onto him, he would shoot one of them down. He probably meant it. (USAF)



ABOVE
Capt Tony "Kimo" Schiavi and Capt Chuck "Sly" Magill smile for the camera. Magill was a Marine Corps F/A-18 exchange pilot who became the first man to fly an operational AMRAAM sortie at the very end of the war. (Tony Schiavi via Steve Davies)

Graeter after he directed them to H2 and H3, where they were to cut off any support that may have launched. Neither found anything of interest and executed a CAP over the original BARCAP coordinates.

> I check to the northwest, go to Auto-Guns and slew the radar down, looking for the next guy. I can hear Maw calling his bandit at 330 degrees for 13 miles when there's another explosion: the guy I've just shot impacts the ground and explodes. Almost immediately afterwards another aircraft hits the ground at my 2 o'clock and at around 3 miles; I can see him tumbling and cart-wheeling across the desert floor on fire. There's an overcast so all of the explosions bounce off of a cloud deck and it's pretty surreal. As best we can tell, the No. 2 guy went into a hard right turn to the west to get away from us, got spatial disorientation and then flew into the ground.

By now the third Mirage had a fairly good idea that it was outclassed and in a perilous situation. It headed back north toward Mudaysis, putting Maw in a 10-mile tailchase situation. Several factors combined to prevent Graeter – who was closer than Maw by several miles – from giving chase to the Mirage: Roland SAM indications were coming from the vicinity of Mudaysis, he was detecting SAM activity in the H2/H3 airfield complex to the northwest, an excessive look-down radar angle was required to detect the low-flying Mirage; and he did not want to light his afterburners to give chase lest he attract attention to himself. For the first time, the odds were stacked in the Mirage pilot's favour. Graeter told the author that to this day he'd have been hard-pressed to have got him, "even with AMRAAM."

CITGO flight learned from the Wing Intel Chief upon landing at Tabuk that their quarry had been Mirage F1EQs. Graeter was officially awarded the second Mirage as a "maneuver kill" a week later. Like many of the pilots who scored kills in the weeks that followed, the realization that he had killed made him pause for thought:

> There was no chance if you got hit by a big missile – an AA-10 which the IRAF used or AIM-7 – you were not going to bail out, you were not going to make a radio call, you were going to turn into dust. That AIM-7 warhead absolutely shredded that airplane [Mirage], just shredded it. It's designed on a head-on engagement to cut the cockpit into shreds – the guy never knew what hit him. When I got back we debriefed with Intel and then headed to the food hall for breakfast. Chuck Magill [see below], who had just got up in preparation for his day flight, told me later that he could tell from my face that this was not all fun and games.

Magill could not possibly have known it, but he too would be experiencing the same emotions within hours.

"I looked like that because I was thinking, 'I just killed a guy, and then I watched another die,'" Graeter reflected. "I am the kind of person who thought that he probably had a wife and family like me and that he was just doing his job. It was hard." Maw reminded Graeter that the Mirage pilots had taken off to kill the F-15Es and that they would have done the same to him had they been given the chance.

THE "GORILLAS'" FIRST DAYLIGHT MISSION

On what was the 33rd TFW's first daylight mission of the war, US Marine Corps Captain, Chuck "Sly" Magill,[8] led ZEREX, PENNZOIL and UNION F-15 flights in protection of a strike force of 50 other Coalition aircraft.

ZEREX – Magill's four-ship – consisted of Lt Mark Arriola at No. 2, Capt Rhory "Hoser" Draeger at No. 3, and Capt Tony "Kimo" Schiavi at No. 4. PENNZOIL flight, led by Tollini, also came from the 58th TFS, leaving Langley's 71st TFS to provide the eight jets of UNION flight. That made a total of 16 F-15s with which to protect an entire strike package of 40 F-16s, eight F-4Gs and two EF-111s. The F-16s' targets consisted of Al Taqaddum and Al Assad Air Bases, specifically a biological and chemical warfare research building located within Al Taqaddum's perimeter.

The 58th TFS four-ships took off at 14:00 local on January 17, rendezvoused with the tanker and then pushed north into Iraq. AWACS initially had problems getting onto the frequency-hopping Have Quick radio network, but this was eventually resolved, much to the relief of all.

BELOW
Capt Tony "Kimo" Schiavi (standing), Capt Rhory "Hoser" Draeger (right) and Capt Bruce Till, relax in the "Gorilla's" crew room. Draeger relaxed by hitting golf balls and his ever-present golf club is to Schiavi's right. He was viewed by many as one of the best tacticians and pilots in the Eagle community. Sadly, he died in a road traffic accident in 1995. (Tony Schiavi via Steve Davies)

> I had my eight Eglin Eagles in close so that we could provide a pre-strike BVR sweep of the target area. These airfields had not been touched so far, so the overall mission commander, the lead F-16 pilot, had already decided that if we ran into too much opposition the mission would be scrubbed.'

Al Taqaddum was estimated to have between 50 and 70 Mirage F1, MiG-23 and MiG-25 fighters; Al Assad was said to have been home to 50 more fighters and was believed to have been home to Iraq's MiG-29s.

Crossing the border, Magill placed his eight-ship sweep flight some 80 miles ahead of the main strike force. Pushing from the 30°N 42°E holding point, AWACS advised him over secure radio that it had two bandits southwest of the target area at medium altitude.

> AWACS gives us clearance to fire on these guys, which is remarkable given that they are about 160 miles away. The bandits are flying a north–south barrier CAP south of Taqaddum AB but I am not worried about them at this point. I am going to continue my game plan, which is to sweep the entire area in a counterclockwise flow: Al Taqaddum, Al Assad and then on over to H2/H3 before leaving the country.
>
> I have my four-ship on my left, my Nos 5 to 8 PENNZOIL are off to my right abreast with me, and I am thinking about the number of bandits more than I am about what they are actually doing over there. The fact that AWACS has called two bandits is making me think that there will be closer to 20 by the time we actually get there. I am thinking that the MiG CAP is probably more of an airborne radar system to make up for the fact that we have taken out a lot of their long-range radars the night before.

If faced with overwhelming numbers, Magill planned to execute long-range AIM-7 shots before disengaging to the south under the cover of the Langley F-15s, which were positioned directly above the main strike force, some 13 minutes' flying time away.

> I do not want to fly directly over Mudaysis AB, where Rob Graeter scored his kills six hours earlier, so we bypass it to the east by 40 to 50 miles. As we press toward the MiGs, closing to 40 miles, I can see that they are slow and low, on a max endurance profile in a "gomer" echelon formation. They are about 360 knots, 1,500 and the trailer is just swinging left and right behind his lead. As we paint them with the radar all we can see is two targets, so I now know that we don't need eight Eagles to take these guys on; I send Rick Tollini and his four-ship to the northwest up toward Al Assad so that they can make sure that nothing hops out of there.

As Tollini checked northwest, Magill's flight overflew a large Iraqi armored battalion, which promptly engaged them with various SAMs:

> The missiles are targeted in what we call an uncorrelated fashion. That is to say that they are locked on, but we cannot tell who to. We therefore all break at the same time: I am on the right hand side with No. 2 east of me and Rhory Draeger and Tony Schiavi are on my left.

BELOW
Two 33rd TFW F-15Cs complete a local area continuation sortie with an RSAF F-5E. The RSAF contributed little offensive capability to the war effort, and was limited for operational and political reasons to defensive operations. The RSAF's single engagement, which led to a double Mirage kill, is extremely controversial because not only did AWACS allegedly specifically task the RSAF Eagle instead of better positioned USAF Eagles and Navy F-14s, but also because the RSAF pilot allegedly very nearly made a complete mess of what was a simple engagement. (USAF)

> I call, "Combat 1!", to jettison our wing tanks, and we dump chaff and flare as we maneuver. It is remarkable – we evade these missiles, going from 30,000 to 18,000 in the process, but as I come out of my break having lost 12,000 with the noise of the radios, engines and RWR gear going off, there on my right is my wingman, in perfect position.

Hard-crewing in the build up to ODS had once again worked for the "Gorillas," enabling a very talented Arriola to maintain two-ship integrity in the most demanding of conditions.

> We are now heading east, so too are "Hoser" and "Kimo." As we clear the threat and pitch back toward Al Taqaddum I look left and there is No. 3 and No. 4 in perfect position, 5 miles west of me and slightly below, so we immediately get back to our BRA [Bearing, Range, Altitude] reports on the MiGs.

The missile launches had severely disrupted the flow of the engagement, coming as they did at the range at which Magill was looking to have the MiGs firmly sorted and tracked – 40 miles. "It was a shock to not know that something was there in the first place, but more so because it came at the time when I was thinking about engaging what we believed then to be a very capable fighter," Magill recalled.

> We regroup and tighten up our wall formation, but my attitude has now changed and my blood is boiling. The SAM launches really have made me angry and it's then that I realize that this is really happening – there'll be no, "knock it off!" call today. We get to about 32 miles from the MiGs when they turn back cold.[10] As soon as they do that I call, "Push it up! Push it up!" and all four of us go into full A/B and ramp it downhill to go as fast as the sucker can take us. I am thinking that the MiGs will either land and the whole fleet will then launch at us, or that they will land and that will be the end of the story.

But Magill was wrong on both counts. As he closed the range to 26 miles, the MiGs reacted, turning lazily back to the south while simultaneously accelerating from 360 knots to 560 knots – fighting speed.

> We're doing about 600 knots, so we now have 1,200 knots of closure. What was happening slowly is now happening very fast, and by the time we get to a 20 mile separation, they are totally hot, just finishing their turn to a bearing of 240 degrees. We are on a 030-degree bearing when Draeger fires first and crosses over my nose above me, telling me that he's shot the guy on my side. We usually use an azimuth sort, but the No. 2 MiG has tucked in real close to his lead and it takes a couple of sweeps of my radar before I can target him and fire.

Because of the proximity of the two "Fulcrums," Draeger had engaged the eastern MiG rather than the western one, forcing him to cut over the top of Magill as he executed his F-pole. Consequently, Magill was forced to positively acquire the western MiG before he engaged.

The contact breakout was eventually forthcoming and Magill wasted no time in firing.

> My first AIM-7 missile looks like it does not have a good flight profile – it's headed straight for the deck. I offset to the right to slow down the engagement, but I don't like the way the missile is flying so I come back, center the dot, then fire the second AIM-7 missile. As it comes off time stopped. I remember vividly the missile's brown and yellow bands and the way that it rolls as it flies out in front of me. I then offset once again.
>
> We get a visual on the MiGs, still in the same formation, at about 7 miles. No. 3's missile hits his MiG square in the canopy: that's the end of the story for that one. My first missile comes up from below and hits the other MiG in the right wing root, tearing a good piece of that wing off. As he noses down my second missile goes right through the middle of his fuselage. It looks like a T-bone.

Magill and Draeger called their kills in and were surprised to hear the radio come alive with cheers of support and appreciation from the strikers.

> It was a surprise because our comm was impeccable up until that point. I maintained focus though. When you fly the Eagle in a multi-bogey environment it is highly visible, you can ask anyone and they'll agree. We blow through the merge, keep the speed on and use our radars in case there are any trailers, but all four of us come up clean.

In the post-merge, Magill looked at his fuel state and realized that he did not have enough fuel to fly the remainder of the planned flow to Al Assad and H2/H3. He also became aware of the fact that there was increasingly more green vegetation below him, signifying that he was getting closer to the Euphrates river and therefore too close to the target. He converted his airspeed into altitude and called for an in-place Immelmann turn to rapidly place them at 25,000ft.

> It was a good idea to gain the altitude, but a bad idea overall because it placed us right in the middle of a SAM engagement zone. Immediately, as I am upside down and heading south, I get multiple SAM warnings and launch warnings [SA-2 and SA-3]. I look at the RWR and see that the range is perfect for the SAMs, so I look out of my canopy and roll wings level. Then I see the missiles, like little space shuttles with booster phases that let them climb up over the top of me before arching back down, straight at me [having missed].
>
> It was laughable because I'm telling everyone that I'm being targeted and I hear, "Two's clean," "Three's clean," and "Four's clean," in response. I am the only guy being targeted! I punch off my centerline fuel tank and break left and right to get away from the threat, then my fuel gage goes to zero. The missiles are relatively easy to defeat, although I lose about 15,000 in the process of doing so.

BELOW
Capt Larry "Cherry" Pitts had only 300 hours in the Eagle when he followed Tollini into battle and downed a MiG-25 "Foxbat." Pitts would go on to become Vice Commandant of the Air Force Academy before retiring in 2005. (Larry Pitts via Steve Davies)

Egressing the area, Magill offset to the west by some 60 degrees to steer clear of the ingressing strike force (which he worried might mistake him for an Iraqi fighter and engage him), and then had a battle damage check to establish whether his faulty fuel gage had been caused by SAM or AAA debris. There was none, and ZEREX flight landed back at Tabuk without further incident. The fuel gage fault was later traced to a faulty "pig-tail" wire on the centerline pylon.

While this sortie would make the history books as the first daytime raid of the war, it should also be recognized as a missed opportunity for the IRAF to have made a stand following their beating on the first night. With many of the SAM systems overlooking the target area not due for attack by Coalition forces until later in the war – and therefore operating with relative impunity – and with both Al Taqaddum and Al Assad bristling with fighters, the outcome of this mission could easily have been different.

Following the initial wave of attacks in the early hours of the first day of the war, the IRAF had reacted just as expected, launching alert fighters and vectoring CAP fighters towards groups of Coalition strikers. It had quickly been neutralized, forcing it to consolidate on Day 2. By Day 3 it was once again ready to mount operations. It was about to lose another seven fighters to the F-15 in a single 24-hour period.

At Tabuk AB on January 19, it was Tollini's turn to lead a mission in support of F-15Es searching for elusive mobile "Scud" launchers. His four-ship OCA flight, call-sign CITGO, remained unchanged from the first mission and he launched in the afternoon with Pitts, Kelk and Williams in tow.

DOGFIGHTING "FOXBATS"

Pitts sets the scene:

> By Day 3 we had realized that they [IRAF] were not the threat that we thought they were. We flew two missions that day, the first of which

04

> was canceled due to weather, but still required us to stay on the tanker for six hours because there was Intel that Saddam Hussein was going to try and leave the country and they wanted us to shoot that flight down. Having hung on to the tanker for six hours, we went back thinking that we were going to have the day off. As soon as we landed the Ops Officer told us to get gas and take off again, so we refueled, got airborne and then rendezvoused with another tanker south of the border. AWACS called two groups of fighters 55 or 60 miles north of us just as we were coming off the tanker.

The flight pushed north at 25,000ft to engage the first group, which was dead ahead and 15,000ft below. "As we pressed closer, another group appeared about 30 degrees right of us and about 60 miles out – both groups were closing on us," Pitts added.

Tollini recalled that AWACS erroneously identified both groups as MiG-29s, but he was more concerned with the MiGs' intentions.

> It looked to me like they were doing some kind of a decoy tactic to get us to go after one while the other came in behind us. We got into a cut-off intercept on the first group from the southwest, pointing towards Baghdad, while they were headed due south from Al Assad or Al Taqaddum airfield, northwest of Baghdad. At 35 miles we locked them up and they started heading east towards Baghdad. As we chased them we saw the second group in a 30-mile lead-trail formation with the first group, in a north-south orientation. That's what made it look like a decoy tactic to me.

Tollini continued to monitor the first group as it headed off to the northeast, then checked his flight to the north to go head on with the second group as it came south.

> Once we locked the second group up they also maneuvered – this time to the west – and I remember that as they turned through west to the north I thought we were going to have to chase them. Fairly quickly they do a 270-degree turn to the south, coming straight at us from 30 miles out in a 3- or 5-mile lead-trail formation, down around 3,000 MSL [mean sea level] – about 2,000 AGL [above ground level]: my intention is to shoot a couple of AIM-7s and kill these guys BVR, so I lock the lead and JB [Kelk] locks the trailer.

With their concentration now focused exclusively on the south-bound MiGs in front of them, Pitts recalls that the MiGs executed a defensive maneuver:

> "Kluso" gets a good lock and is ready to shoot at targeting range when they go to the beam [perpendicular to Tollini and Pitts] and take it down low. We lose them, "Kluso" never gets his missile off and we totally lose situational awareness for a little bit. As we keep pushing north we realize that one guy has come back in hot. He's coming left-to-right across our formation, 5 miles out front, at 300 and doing 700 knots. He's also lost his SA and doesn't know we're there.

Mark Williams is the first to see the "Foxbat" because he's on the left-side of the formation when the MiG crosses left-to-right in front of it. However, it is Pitts who's in the best position to engage. He realls:

> I call, "Engaged!" and lock him up with my radar in a high-to-low weapons conversion where I actually pull 12-g and seriously overstress the jet! He's going so fast, however, that as soon as I lock him up he gimbals me – flies off of the radar's coverage – and I'm thinking that I'll never find him again because he is going like stink.
>
> Remember that this is the second mission of the day and that the weather was bad, he's now on top of a low overcast and as I do the conversion I see him and re-lock him with Auto Acq. As soon as I do that he does a defensive turn and breaks into me, going from an easterly heading through south and then back to west. By the time he turns from west to north I am in weapons parameters and at fighting speed of about 420–450 knots, but he's way above the Mach flying this huge defensive turn. I get inside his turn very easily and again call, "Engaged!" because I have not heard "Kluso" clear me to fire. "Kluso" responds with, "Press!" which makes me flight lead for a short time and indicates that he's now supporting me. I'm now 9,000 ft behind the guy,

OPPOSITE
From the rear it is easy to see how a MiG-25 could be mistaken for an F-14 in a fast, hard-turning engagement. When Tollini visually re-acquired his "Foxbat" he had to be absolutely sure of its identity – particularly since he knew there were Navy F-14s in the area. He called calmly: "Everyone come out of burner, now!" Only when the aircraft in front of him stayed in afterburner did he press the pickle button. (USAF)

> close to a tail aspect, and I select an AIM-9, get a good tone [the missile sees the target], uncage it and still have a good tone [the missile is tracking the target without the aid of the radar], so I launch. He immediately decoys it with flares.

The MiG's timely release of countermeasures had spoofed the missile into shifting track from its hot exhausts to the even hotter burning magnesium flare.

> As soon as he hits north he stops turning and tries to run, still at 300 and now doing 500 knots. I select an AIM-7, feel the clunk [as it releases] and then I look to the right and see that it is almost flying in formation with me. The rocket motor then lights and it accelerates off, right at him and past his canopy without fusing.

Now at 6,000ft with a pure tail aspect, Pitts re-selected an AIM-9, got a good tone, and uncaged:

> Just as I am about to fire, he puts out more flare and drags [the seeker head] off before I can take the shot. I re-cage it back to the radar, get a good tone and shoot, but he decoys it with flares again. He's fighting pretty hard and I am thinking, "Man, I am going to have to gun this guy." I select another AIM-7 and shoot, and this time the missile goes right up his tailpipe and explodes. "Kluso" must have been thinking, "'Cherry' needs some help here," at the same time because he shoots an AIM-9 which goes straight into the fireball. The guy bails out and his ejection seat comes right over my canopy – I thought it was going to hit me – and I start hearing his emergency locator on GUARD [the emergency radio frequency].

Pitts made his "splash" call and pulled up into a left-hand, climbing turn. As he did so, he saw the other "Foxbat." "I call, 'Two, second MiG-25, my nose, 5 miles.'" Tollini responded with, "Engaged!" but struggled to immediately identify the aircraft as a MiG-25, F-15 or F-14.

Tollini recalls the engagement from his own perspective:

> I have "Willie" Williams searching high and "Cherry" Pitts searching low after the second group of MiGs beamed us and we lost them on radar. Fortunately "Cherry" is able to grab the trailer as he finishes his beam to the east and then turns due south again, and I actually get the lead back on radar momentarily before both of them fly off of our radar scopes. "Cherry's" guy starts his right-hand turn underneath us, and my guy does a high-speed turn through the south and I see him leave the fight.

Tollini transitioned from lead to wingman when Pitts called engaged on the first "Foxbat," following Pitts through the split-S maneuver that placed him behind it.

> The MiG is in his right-hand turn and we are at very close range as "Cherry" camps behind him. I join the fight in a left-hand turn from the southeast and cut across the circle as the MiG continues his turn from the west towards the northeast. It's then that "Cherry" starts shooting off all of his missiles [laughs]. He's not having any luck, so I radio, "Two, come off," about which he later said to me, "'Kluso,' I don't remember you saying that!" [laughs again]. My first shot gets there a split second later than his, and although I do not personally see the guy punch out, "Cherry" says that my missile got there seconds after the seat came out of the aircraft.

With the troublesome "Foxbat" dealt with, Tollini began his own engagement:

> As "Cherry" peels off to the west I flew right behind his MiG and watched it enter the undercast and impact the ground. We had already dropped our wing tanks and we are all going really fast, so I pull into a high-*g* right-hand-turn through east to south. As I do that I have an Auto Acq mode slewed out to the south – I think more by accident than planning – and as I come around the corner to the south the radar grabs the other guy as he comes back into the fight.

The "Foxbat" re-entered the fight from a northerly heading and, although both Pitts and Tollini missed the call at the time, AWACS had made a timely call to advise CITGO flight of the impending merge.

> The instant I snag him, "Cherry" sees him visually and calls him to me; then it becomes an issue of ID again. When we merged the first

> time we had good ID, but having been spit out of the fight I don't know who he is when he comes back in again. I don't know where "JB" and "Willie" have gone[11] and I know that there is a Navy package out there, so I am sitting barely more than a mile behind him, looking at his tail, but unsure of what he is. What I can see is his two huge burner plumes, so I ask on the radio if anyone is in burner. Having received various responses I call everyone to get out of burner – working on the basis that if he's one of us he'll comply. Well, he doesn't, so I look at him more closely and see that he has two missile pylons under each wing and I know that it's not an F-15 or F-14. That's the moment I know that he is a "Foxbat." Then I start shooting.

The spare mental capacity that allowed Tollini to indulge in such dynamic thinking is a great indicator of how effective USAF F-15 training really was. At a time when temporal distortion, channelized attention, fear and cognitive saturation can blunt the senses of any fighter pilot, his efforts to ID the target were characterized as "outstanding," by Pitts.

With the MiG positively identified, Tollini closed for the kill.

> I am in full burner, camped back there in pure pursuit. He's not like the first MiG in that he's not putting out any chaff or flare – maybe he could not see me because I was camped in his deep-six, or maybe he'd run out of flare; I don't know – but he stays in this high-g turn. My first AIM-7 is at low aspect, maybe 20 to 30 degrees off of the tail, and I hit the pickle button and wait, but I don't see the missile flying out in front of me. We don't know for sure, but we think the rocket motor failed to light.[12] I thumb forward on the throttle-mounted weapons select switch to select an AIM-9, at which time what looked like a single flare pops out of the aircraft, it was not really bright and it could have even been him punching out, but I think I would have seen more if that were the case. In any case, I am not that confident that the AIM-9 will get there having seen what happened to "Cherry's" missiles, so as soon as I shoot it I thumb back to AIM-7 again. The AIM-9 flies close to his burner cans – through the plume – but then sails wide and misses. I then shoot the second AIM-7.

In the temporal distortion that many pilots experienced at the time of their kills, Tollini watched the missile guide in a lag-pursuit mode for what seemed to him like minutes. It flew up from beneath the "Foxbat" and then punctured its belly, exploding milliseconds later. "The explosion is huge, like the *Death Star* from the *Star Wars* film! The "Foxbat" totally disintegrates and I am amazed because that had not happened to 'Cherry's' MiG."

ABOVE
By the time Tollini and Pitts were done with the engagement they had expended most of their Sparrows and Sidewinders, and Tollini found himself looking to go to guns. The skill of the "Foxbat" pilots led both men to ponder the possibility that these MiGs had been flown by other than Iraqi pilots. This was one of the few engagements of the war where the enemy put up an effective level of opposition. (Gary Klett via Steve Davies)

Despite the fact that Pitts had flown the visual engagement extremely well and had employed his weapons properly, the first "Foxbat" still required a total of five missiles to down it. To illustrate the point, every one of Pitts' shots would have been classed as kills in a peacetime exercise. He credits the "Foxbat" pilot with having put up a good fight – one of the few IRAF pilots to do so throughout the war.

Tollini's main concern had been to end the fight as quickly as possible and that remained the priority. AWACS was warning that the original group was now headed south again and his flight had already been sucked into one merged engagement in what had been a fairly "ugly" intercept. Fortunately Pitts and Tollini exited the area without any additional complications. The original group called out by AWACS never did threaten CITGO (Eagle callsigns were reused during the war) flight or the strikers, although Kelk and Williams were still up high covering if they had.

The debrief for this flight was lengthy and intense. The mission had gone far from according to plan and there was no shying away from the customarily candid mission debrief; a *modus operandi* of every-day peacetime training that, "Kluso" argues, is one of the reasons that the USAF was so successful in its quest to kill MiGs.

POP-UP "FULCRUMS"

The 58th TFS claimed its 8th and 9th kills on January 19, (Day 3), when Craig "Mole" Underhill and Cesar Rodriguez received an airborne re-tasking at 10:00 local, four hours into a six-hour E-3 and KC-10 HVACAP mission in the western sector. The mission leader, Rodriguez, described the events that followed as, "Iraq's ultimate attempt to score an airpower victory."[13]

The re-tasking came when Langley F-15s, which were supposed to provide a post-strike sweep, were unable to take off.

> We were re-roled to provide protection for a strike package that had not been on the ATO: 36 to 38 strikers made up of F-16s and F-4Gs. As the tasking came through we were approaching a refueling decision, so I sent No. 3 and No. 4 back to the tanker first, they then relieved us and as we were on our way to the tanker we received the latest briefing from "Kluso," who was leading a four-ship ahead of us.

Tollini was leading another CITGO flight in support of the "Scud"-hunting F-15Es (see above), but acted as a radio relay when the tasking came through.

Rodriguez received the strike's grid coordinates, special instructions and information associated with his mission. He then left the tanker and instructed No. 3 & No. 4 to remain on the HVACAP,

> knowing that going as a two-ship, and that because the first strikers would be on their way to the tanker by the time we got there, we'd have an increased risk factor: there was a fine balance between accepted risk and mission execution.
>
> The original plan was the post-strike sweep which was to fly behind the strikers, so we were prepared to be the clean-up guys. As it turned out, "Kluso's" flight was engaged in the same area [that Rodriguez's strikers were heading], so we re-roled once again to change from a post-strike sweep to a pre-strike sweep. That meant that we had to catch up and get ahead of our strikers so that we were in position to provide them with protection. We pushed it up and got high and fast, initially picking up a single contact to the northeast of the target area.

As Rodriguez continued to speed towards the front of the package, he handed this contact off to Underhill to keep an eye on while he went back to a search mode and found a group to the northwest of the target area:

> The biggest threat to the package was the northeastern contact, so I passed the northwestern group to AWACS in the hope that they would target them with a two-ship of OCA F-14s that were in the area. We put both radars into the eastern contact and flew a vanilla intercept: single contact breaks out into a group of two. We know now that it's going to be 2 v 2 and that they are MiG-29s, so we execute the press and the group flies some anti-Western maneuvers to deny the radar accurate data and defeat the AIM-7. Prior to that we had intelligence that there would be pilots other than Iraqis participating in the air picture and this validated, in my opinion, that possibility. These guys had it together and knew what they had to do.

The MiGs had beamed to the west, held the beam maneuver until out of the AIM-7 WEZ and then dragged CITGO 11 and 12 into the Baghdad "super MEZ," the expansive missile engagement zone that covered Iraq's capital. The maneuver did not fool Rodriguez, but it was clearly exceptionally well-executed.

Aware of the MiG's intentions, Rodriguez elected to continue the pursuit because he knew that it would allow the strikers to place bombs on target unharassed. "We started to receive RWR indications that the SAMs were looking at us and getting ready to target us, we were also being informed that the last set of strikers were coming off target." Rodriguez turned his flight southwest, at the same time as the western AWACS informed him that there were bandits off his right wing at 13 miles. The mission had been complicated by the need to transition from the western E-3 C&C structure to the central

C&C structure following re-tasking to the post-strike sweep, and it quickly became clear that communications had broken down.

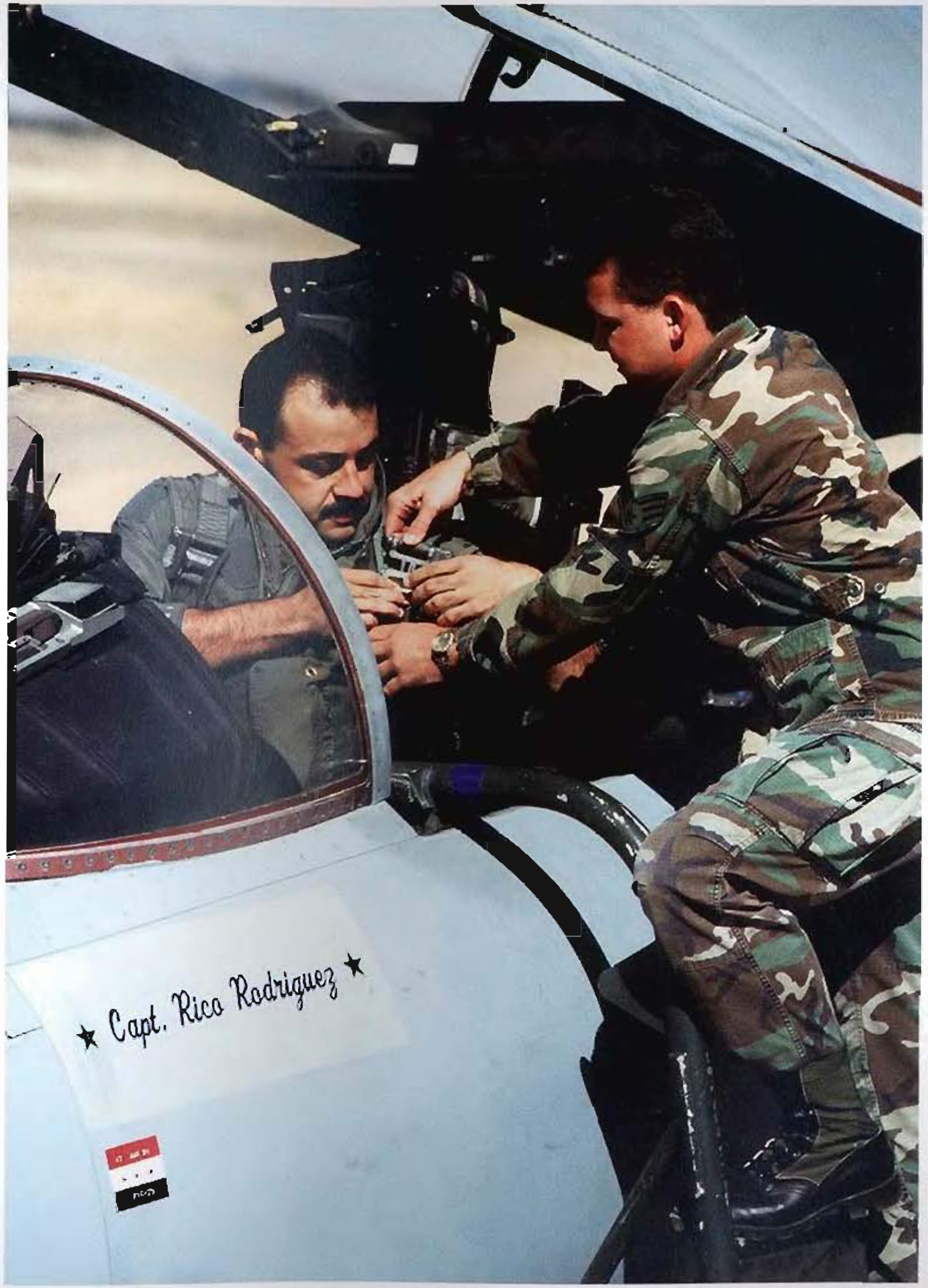
This group was actually the same one that Rodriguez had handed off to the central AWACS controller to vector the Navy F-14s onto at the start of the push towards Baghdad. He recalls:

> The central controller was having a hard time just keeping his AOR [area of responsibility] under control, so the western AWACS called on Guard: "Pop-up contacts, 330 degrees for 13." At 13 miles I have no option to disengage without any SA, so I direct an in-place turn to 330 degrees, jettison wing tanks and put my radar into the location of the target. I lock onto a target at 8 miles and initiate my ID matrix, at which point I have an RWR indication that I have a "Slot Back" radar MiG-29 locked onto me. I notch to the south and pass as much information to "Mole" as I can: "Altitude 8,000, off of my nose." My concern is self-preservation, so I now have 570–580 knots on the jet, I'm well below 500 and I'm trying to stay on the beam while my ECM and chaff do all that they can.

"Mole" locked the bandit up and used his own onboard systems and a call to an RC-135 River Joint to secure positive confirmation that the target was a MiG-29. Although at the time neither "Rico" nor "Mole" knew it, a second MiG-29 was some 12 miles behind its leader. Streaking south, Rodriguez looked over his right shoulder to see if he could spot the MiG.

> "Mole" fires a single AIM-7 and as he calls, "Fox 1," I look over my left shoulder and see his missile come off and fly out over the top of my tails. As the missile motor burns out, I look to the left of the last source of smoke, at which point I pick up the silhouette of a MiG-29 roughly 4 miles off of my right wing. Shortly after that the missile impacts and there is nothing left; it's one of the embedded memories in my brain – there was the silhouette and then seconds later there was literally nothing.

For the duration of the engagement the MiG had sustained a lock on "Rico," flying pure pursuit at him but unable to employ his



RIGHT
Capt Caesar "Rico" Rodriguez straps into his Eagle for another combat mission following his first MiG kill on January 19. He was the only pilot in the war to enter a turning fight with a "Fulcrum." (USAF)

weapons. Rodriguez reckons that it was probably a combination of his ECM, chaff and the efforts of other airborne platforms that denied the "Fulcrum" the ability to launch a missile at him.

> We received another call from the western AWACS: "Second group, north, 10," at which point we execute an in-place check turn to the north. "Mole" and I are about 2.5 miles apart and I am visual with him off my right wing [and slightly ahead]. I look up and see a smoke trail – not a missile trail, but engine smoke – so I put my Auto Acq out there and "Mole" and I simultaneously lock him up.

Underhill later wrote that the MiG initiated a hard turn into him when his Auto Acq mode triggered its RWR.[14]

> We started going through our ID matrix and the target displays a friendly electronic return to both of us. I direct a break lock and re-lock, but the same thing happens again. I now direct a VID pass and push "Mole" out to a 5-mile line-abreast formation. The bogey is closest in azimuth to my nose, so I fly the pass. I bring the TD box into view and look at about 8 miles, but it's just a dot and I cannot tell what it is. I look again at about 4 miles and I see a Western-looking silhouette that looks a lot like an F-15 or an F/A-18, so I don't declare him hostile. At about 2 miles I look once again, but I'm no longer thinking about taking a pre-merge shot, so I plan to merge with this bogey at 50ft off of his left wing. As I cross his wing-line, I see that he's a brown- and green-camouflaged Iraqi MiG-29.

The MiG was flying in the region of 8,000ft and Rodriguez had flown a low-to-hi VID engagement into the sun, constantly staying below his adversary's plane of motion.

> I declare, "Hostile, MiG-29," and begin a hard left turn when he starts his left turn, so that we have what looks like a classic two-circle fight.

LEFT
Capt Anthony "ET" Murphy walks purposefully from F-15C 85-0102 on February 7 having just downed two Su-22 "Fitters." Legend has it that Murphy also killed a Su-7 in the same engagement, but was allegedly later pressured into "giving" that kill to his Wing Commander, Col Rick Parsons. When the author asked Murphy about this in 2005 he was diplomatically evasive, but his paperwork after the mission makes claim for three kills, and Parsons' for one. When Parsons' was turned down, Murphy's claim was subsequently "reviewed" and amended and one of Murphy's kills was transferred to Parsons. (USAF)

> Initially his turn is level, so rather than stay horizontal with him I transition into a split-S maneuver to cut across his circle [his turn]. "Mole" is now in the high 20,000 regime, in a cover position, looking for an option to enter into the fight.

The fight quickly turned into a single-circle flight, where both aircraft attempt to out-turn each other in what looks like a constant spiral, but "Rico" held the advantage because he had managed to get behind the bandit's 3–9 line[15] in the first couple of turns.

> He recognizes that I'm there, and I think that he may even have visually seen "Mole" up there. The fight now turns into a left-hand descending spiral with me having quite a bit of an energy advantage that I convert into a WEZ [close to within firing parameters]. I spend time inside his turn circle with a high heading-crossing angle, then I flush to the outside of his turn circle before regaining energy, aligning circles, and then coming back to the inside of his circle looking to employ an AIM-9 against him. As I cut back inside the circle for the AIM-9 there is an opportunity for "Mole" to come in and take the shot, but I opt to call him off and continue my own pursuit. We're now down below 1,000.
>
> He tries to fly a split-S maneuver in what looks to me like a "cobra" [a high angle of attack pitch-up or pitch-down, the latter in this case, since the MiG was inverted]. I come out of the fight and dip my wings to pick up the tally-ho [visual contact], at which point he impacts the ground. He hits the desert floor and then tumbles with all the momentum he had for what seems like several miles. Meanwhile "Mole" and I are getting the hell out of Dodge. "Mole" calls, "Snap south, I'm tactical right side," and I look left and there he is, directing our separation."

Short of fuel and calling for a tanker to come north, the pair retreated under the cover of CITGO 13 and 14 (Capts Mike "Fish" Fisher and Pat "Pat-O" Moylan) who had raced north from the HVA CAP track to provide support.

ESCAPE TO IRAN

January 26 saw Capt Rhory "Hoser" Draeger and his wingmen, Capts Tony "Kimo" Schiavi and Cesar "Rico" Rodriguez, each down a MiG-23 "Flogger." They were Draeger's and Rodriguez's second kills, and came when four "Floggers" attempted to relocate to Baghdad and the sanctuary of its Super MEZ.

Schiavi recalled:

> For this particular day we changed our original paired four-ship of Draeger No. 1, me No. 2, Chuck Magill No. 3 and Mark Arriola No. 4 to Rhory Draeger and me, Cesar Rodriguez at No. 3 and Bruce "Roto" Till at No. 4. We were assigned as a HVA protection mission north of the border in the western sector between Baghdad and the H2/H3 airfield complex.[16]

The weather was good that day, with only a few layers of mid-level cloud and a low-level overcast. The four took off following afternoon launch, and received fuel from a tanker refueling south of the border, Schiavi recalls.

> The first part of the mission was uneventful and quiet. It was a mentally challenging mission from the start because our mission required us to know where all the friendly aircraft were. We had spent time prior to the mission learning and studying the ATO. That allowed us to position ourselves in support of other flights once we got out there.

As CITGO flight cycled to and from the tanker in pairs, there were overlaps – short periods of time when the whole four-ship was on the CAP station simultaneously before two aircraft had to leave for the tanker.

> It was just as "Rico" and "Roto" leave to get more gas that AWACS calls to say that it has MiGs airborne from H2/H3 in western Iraq and headed towards Baghdad.[17] At the time we are headed south and "Hoser" decides that we needed to get our four-ship back together again before we go north after these guys. The geometry is such that the MiGs are some 80 miles in front of us by the time we achieve that, but "Hoser," being the talented and smart guy that he was, asks AWACS if we can follow them anyway. These guys are headed towards the Super MEZ, which is not a place you want to go flying through, but there's plenty of time until we'll get to that point, and anyway, we don't know that these guys will not turn back south at some point. "Hoser" was

> one of those guys who was always thinking ahead, "How could this thing turn out differently?" whereas the traditional view would have been, "Hey, we're in an 80-mile tail chase with these guys. Why are we even wasting the gas?"

As Draeger's flight approached the SAM rings outside Baghdad, AWACS called to say that it had another flight of four MiGs taking off right behind the first group.

> That puts us in a geometry situation because we have four MiGs in front of us at about 70 miles, and now we have another four at our left 7 o'clock – we could have quickly found ourselves sandwiched between the two. "Hoser" reacts immediately and orders a delayed four-ship 90-degree left turn to almost exactly 270 degrees, placing the four MiG-23s right on our nose.

The Eagles bore down on the "Floggers" in a wall formation: Schiavi was the furthest north in No. 2 position, with Draeger at No. 1 to his left. Rodriguez at No. 3 was to Draeger's left and Till at No. 4 was farthest south.

Aware that the IRAF had lost the will to fight and would turn tail as soon as a RWR indication showed they were being engaged, Draeger had briefed that he wanted everyone to stay in raw radar search mode – RWS – so that the gap could be closed until the MiGs could not escape.

> We did not want to get into any turning merges with anyone if we did not have to, so we get our MiG-23 EID and AWACS clearances out of the way well before we can shoot. The MiGs are at 500 and we are flying a cut-off intercept on them. At about 40 miles, AWACS tells us that one of the MiGs has returned home, so we now have a radar picture of a three-group "Vic" – one guy out front, the other 2 guys flying behind and either side of him.

Rodriguez added that Rivet Joint also confirmed the EID on the MiG-23s.

Draeger ordered a jettison of wing tanks to allow superior maneuverability and greater speed with which to increase their WEZ. "We're doing about Mach 1.2, coming downhill at the MiGs and initially we don't think we'll be able to see them because there's a bit of an undercast below us," recalls Schiavi.

Rodriguez adds, "The first issue is, 'are we going to be able to see these guys visually through that undercast?' At about 25 miles there is this 'sucker hole' that we see through, so we all converge within a mile of each other to try and squeeze through it. We scare ourselves doing that. At 18,000 the sucker hole starts to expand and we now have room to maneuver." Schiavi says, "'Hoser' then calls a targeting plan – he's going to take the pointy-end of the Vic, he targets me on the northern trailer and 'Rico' and 'Roto' on the other trailer to the south. We are fortunate that over the desert environment we are not getting too much ground clutter and we can break the guys out on the radar with ease."

Next Draeger ordered No. 3 and No. 4 to execute a check turn to create separation following the formation's unintentional compression as they penetrated the weather. Wary that the AIM-7 likes to pull lead on its target and that the check turn placed his second element slightly behind him, he also had the presence of mind to warn Till to be careful not to fire his AIM-7s at a time when they might fly towards and into him. "No. 4, don't shoot through me," he transmitted. Schiavi continues,

> Up until now, things have been very calm: you'd almost think that we're flying a training mission over the Gulf of Mexico at our home base in Florida. "Hoser" shoots an AIM-7 first [at 11 miles], but his missile has a motor no-fire. He shoots again and the Sparrow heads towards the lead "Flogger." By now we are calling tally-ho on the MiGs and we see "Hoser's" missile hit the back end of the aeroplane. There is this little explosion and a dust cloud, but "Hoser" calls, "Splash 1 from 1." When he sees the "Flogger" fly through the explosion, he selects an AIM-9 and pursues [him].

Trailing smoke, the MiG-23 turned north:

> Just as "Hoser" is about to fire an AIM-9 at his "Flogger," it begins to fall apart. Its engine catches fire and eventually its fuel cells explode, leaving another charred streak on the desert floor.
>
> Listening to the cockpit audio tape you can tell that the adrenalin was now pumping because as soon as airplanes start blowing up,

BT
BT
AF
79
058

ABOVE
Bitburg's Eagles were particularly successful in the latter stage of the air war. These "BT" jets, photographed over West Germany just prior to the war, carry the primary weapons load for the Eagle at the time: four AIM-9M Sidewinders and four AIM-7M Sparrows (USAF)

> everyone's voice goes up about six octaves! I fired about seven or eight seconds after "Hoser," but I use two missiles because I am coming in at an angle and the guy is low. I also want to be sure that this MiG dies. We came down very fast through some clouds and moist air, so we were trailing condensation and wing-tip streamers pretty good – the MiGs see this and begin a hard right-hand turn into us. At that instant my first missile hits the front of the second MiG and it basically vaporizes him. My second missile goes right through the fireball.

Rodriguez and Till had simultaneously engaged the final MiG. Till shot first but his first AIM-7 hung, another experienced a motor no-fire and his third impacted only seconds after Rodriguez' AIM-7 hit the target. Rodriguez recounts,

> I fire two AIM-7s which both proceed inbound toward their targets. My missile hits at the same time as "Kimo's" missile hits his target, "boom!" The MiGs are about 400 off of the ground and the fireball chars the desert floor [3 or 4 miles south of Draeger's MiG wreckage].

The charred streaks and scattered remains from the trailing "Floggers" straddled the main highway from H3 to Baghdad, serving as testimony to the Eagle's complete dominance for weeks to come.

Schiavi adds,

> We come off north, away from the fireballs, because we just want to get the hell out of there as fast as we can. We turn south and punch off our remaining fuel tank, but we are critically low on fuel. The tanker, God bless him, comes north across the border to meet us, allowing us to get back home to Tabuk rather than having to divert to another airfield. We went with "Roto" to an unused area near the base and he jettisoned his hung AJM-7, then we flew victory rolls over the base and came in for a full-stop landing with all the maintenance guys on the base there to meet us.

The ability to get the tanker so quickly is in no small part down to the fact that as CITGO executed the intercept, Draeger and Rodriguez had told AWACS they would soon be short of fuel.

QUADRUPLE KILL

On January 27, 1991, Captains Jay Denney and Ben "Coma" Powell conducted what is arguably the most successful single engagement of the entire war, resulting in the destruction of four IRAF fighters. The engagement is also noteworthy because it demonstrates that there remained some form of coherent IADS some two weeks into the war, and because of the proximity of the engagement to Baghdad city itself.

"Our four-ship shows up at our CAP station south of the border and we check in with BULLDOG AWACS who immediately tasks us to Charlotte CAP [a CAP location], 75 miles southwest of Baghdad," Denney told the author:

> Once there, an hour or so passes before we get a snap to a pair of bogeys southeast of Baghdad. "Coma" and I press toward them, past Al Amara where there were SA-3s, ending up in a 40-mile tail chase against an adversary who is clearly "husbanding" [pulling back to Baghdad] and does not want to fight. With fuel becoming more of a consideration we pull back to 30 miles southeast of Al Amara and watch them for 15 minutes before No. 3 and No. 4 replace us and we go and get gas. By the time it's No. 3 and No. 4's turn to get gas, another snap comes in: "Bullseye 130 for 80," which is east of Nazirah and north of Basra. The bogeys are headed northwest, so we make a hard right turn and press. Everyone else on frequency starts looking for them too. I call the contact to BULLDOG and as he hands-off the contacts to us the Aux frequency is full with all of the other F-15s calling up to say, "good luck!"

Believing that they were dealing with a simple element of two Iraqi fighters, Denney refined his interception:

> They are down at about 5,000 headed northwest going at 350 knots calibrated, we are eastbound trying to cut them off. When we get inside 20 miles they turn out to the northeast toward the Iranian border, so we stay up at around 30,000, at Mach 1.1, in full A/B, trying to get the closure [before they cross the border]. As they make their turn northeast, I tell "Coma," "break lock, don't spike them," because I don't want to give them any awareness that we're chasing them down. We get within 15 miles and they make a turn back toward Baghdad, giving us a geometry cut-off. The first contact to turn is the western one, and the eastern one trails in a 4-mile echelon formation to the northwest. I am to the east, my wingman on the west, and we ramp down on these guys with about 300 knots overtake. As we continue to close we go through our ID matrix. AWACS calls, 'Bandit, bandit, cleared to fire' and we are now just trying to get into weapons parameters.

Descending to 3,000ft, Denney and Powell spied their targets' shadows.

> I am a little bit out in front of my wingman and I take the first AJM-7 shot at about six miles. I get a good fly-out and lock, the missile goes right to him but I don't actually see it fuse. The best guess we have is that it either did not fuse in time and the warhead exploded into the sand below him, or, if it did fuse, the warhead damage was not enough to stop him flying. "Coma" employs an AIM-7 at his target and at this point in time we still think that we have two single contacts. I watch his missile fly out at the same time as my MiG starts a gentle left turn at about 2g. As he does so I select an AIM-9 and shoot within 2 miles: it hits him directly and the explosion looks like a Molotov cocktail because he is low, the desert is flat and he is full of jet fuel.

Denney is down to about 3,000ft when Powell's first missile also misses.

> He immediately calls, "Tally two." He's well above me on my left at about 12,000 and has a better view than I, but I look over to the left to see his group: I spot one MiG and as I keep scanning left-to-right I see another on my right. I call, "Confirmed, tally two, I'm engaging north."

Unaware that there had been more than two MiGs from the start, Denney was actually talking at crossed purposes with Powell. Powell's "Tally two" call came because he had been able to visually discern that his single target was actually a MiG-23 and Mirage F1EQ in fingertip (extremely close) formation. The call prompted Denney, however, to re-scan his own horizon, allowing him to pick-up the dead MiG-23's wingman.

> Powell rolls upside down, shoots a second Sparrow and kills one of them. I'm now about 3,000ft to the east of this and as the first one blows up I see the seat come out, the 'chute opens with one swing and then falls straight into the fireball on the ground. Almost immediately the third MiG blows up and falls apart. I'm now looking at the fourth guy to the northeast who has entered a left turn. I order Powell, who is still off to my left, to come right as I descend to 300 with the MiG at 50. I can't get a radar lock, so I uncage my AIM-9 and as I go to fire he reverses, leaving me with a simple, dead-six AIM-9 shot right in the behind. The missile comes off, hits him and I'm only about half a mile behind the explosion that follows.
>
> We're now about 40 miles outside of Baghdad and we can see some of the buildings of the city from where we are. We are starting to approach 'SAMPAC-2' [part of the Super MEZ] but we have not experienced any SAM indications so far. But the second the fourth MiG blows up everything comes online and our RWR records a frenzy of activity – they had been holding off so that they did not shoot their own guys. We are in their WEZ, so we do a hard right to the south, stay low, punch off our wing tanks and get the hell out of there. We eventually get fuel from a tanker who has come 75 miles north of the border to meet us. We get gas and continue to CAP for a few hours more.

ANOTHER QUADRUPLE KILL!

On January 29, Captain David "Logger" Rose, attached to the "Gorillas" from the 60th TFS "Crows," scored kill No. 21 when he downed a MiG-23 during an OCA sortie. This was followed by an eight-day hiatus where no MiGs were downed. The temporary drought was lifted in true style by Capt Thomas Dietz and Lt Bob Hehemann, two of a 53rd TFS paired four-ship from Bitburg who had flown together extensively in the months leading up to the war. Moreover, Dietz and Hehemann had already mixed it up with a couple of MiG-25 "Foxbats" directly over the heart of Baghdad without success.

By early February the omnipresent F-15 force was no longer tied to particular packages, but allowed to roam within sets of coordinates to allow optimum flexibility. The 53rd TFS was tasked

BELOW
It wasn't all hard work! Jay "Opie" Denney and Jethro Miller of the 53rd TFS play guitar with a stand-in backing singer at PSAB. Denney and Capt Ben "Coma" Powell scored two kills apiece in an incredible engagement. (Jay Denney via Steve Davies)

with providing F-15s to execute 24-hour roving patrols of four F-15 four-ships which encircled Baghdad and cut off the IRAF's escape routes to the north and the east. Dietz and Hehemann were on one of these missions that day.

Said Dietz:

> We are on CAP station to the east, right on the edge of the Iranian border when AWACS tells us that it has Iraqi aircraft just north of Baghdad, coming at low altitude, east-southeast. We orient ourselves in that direction and pick them up on our radar; beginning an intercept to see if we can get them before they reach the border. "Gigs" – who has only 100 hours in the airplane and is a very young but very talented guy – and I are No. 3 and No. 4 and are on Cindy CAP while our squadron commander, Randy "Bigs" Biggum, and Lynn "Boo Boo" Broome are at the tanker getting gas.[18]

As they committed against the contacts, AWACS attempted to attain a positive identification, freeing the Eagles up to inspect the local airspace with greater scrutiny.

> We sanitize the airspace around the contacts and then, in accordance with our training, meld our radars so that we are looking at the same radar picture. Gigs then takes one group [northern] and I take the other [southern]. We start at 33,000 and descend from 50 miles away, getting clearance to fire before we get to visual range and having punched through a cloud deck. We lock them up and take our first shots with plenty of closure on them. Following our missiles I get a tally on two guys at low altitude and in close formation – maybe 100 apart. To this day I have no idea what happened to my AIM-7, so I roll in behind them somewhere inside of 2 miles and I shoot an uncaged AIM-9 at each – as the AIM-9s streak away about 2 seconds apart it looks like they are almost flying formation on each other.
>
> It's easy in this environment to get temporal distortion and everything seems to slow down; the missiles guide as advertised, they fly straight to the aircraft, I see the warhead detonate and then nothing. It looks like they have had no effect on these guys. The next thing that I notice is some flame trickling out of the aircraft on the left, and then some flame trickling out of the aircraft on the right. A few seconds later both aircraft impact the desert floor and there are these fireballs that fly along the desert like napalm. There are no parachutes that I can see.
>
> It then occurs to me that this has been too easy and that I need to look around me and find my wingman and any other aircraft out there. I look to the left and there's an aircraft very close to me, with its nose pointed out in front of me, in the same plane of motion as me, and in a set-up where he can conceivably shoot his gun at me. As my brain processes this it becomes clear to me that this airplane is on fire, the canopy is gone – the guy has ejected – and that "Gigs" has shot him. Even further to the left I can see the wreckage of another guy who he's shot as it hits the ground.

Hehemann narrated the events as seen from his cockpit:

> The Iraqis are in a lead-trail formation from our perspective, but are actually in an echelon formation. I take the northern group and lock the northernmost guy at the north side of the formation, "Vegas" cuts

LEFT
Surrounded by Air Force and civilian cameramen, Capt Tom "Vegas" Dietz (right) and Lt Robert "Gigs" Hehemann "high-five" following their February 7 kills. The pair was the war's most successful MiG-killing duo. (USAF)

> underneath me to get to the northern group, and at that point I decide that I don't need my radar. I can see one guy so I thumb back to AIM-9 and let the first missile rip at him. As the missile is in the air I pick up another guy to the right, so I point my nose at him and with about 490 KCAS on the airspeed, inside of a mile, shoot a second missile. I then pick up a third guy: just as I am about to pickle [third AIM-9] he turns into a fireball – he turns out to be the second guy that "Vegas" had targeted.
>
> I look back at the first guy I shot at and it reminds me of someone taking a cigarette and scraping it along concrete – a trail of burning embers on the ground. The second guy is still flying, but right then the AIM-9 impacts the engine and the explosion cuts the airplane in half. That big straight "Frogfoot" wing just flat-planes in the wind, the tail comes off, the airplane slows immediately, starts to yaw and ends up nose pointed at me looking like it could threaten me. I sharpen my right turn and pick "Vegas" up at my right 3 o'clock.

From the first AIM-9 being fired to the last Iraqi fighter exploding the time elapsed was no more than 15 seconds.

IN SUMMARY

The next day a section of two F-15Cs was flying BARCAP along the Iran–Iraq border when it engaged and destroyed a gaggle of four escaping Su-7/22 "Fitters" in a tail chase. These, plus two other IRAF aircraft destroyed by F-15Cs following the cease-fire when they violated the UN mandated No-Fly Zone over southern Iraq, brought the total of Iraqi aircraft shot down by USAF Eagles to 34 (16 by the 58th TFS, 11 by the 53rd TFS, five by the 525th TFS, one by the 32nd TFS and one by the 71st TFS), to which may be added two IRAF Mirages shot down by an RSAF F-15C, for an Eagle grand total of 36 aircraft destroyed. Other Coalition aircraft destroyed another five IRAF aircraft,[19] meaning that the IRAF lost 41 aircraft in aerial combat. Another 81 aircraft were confirmed destroyed by bombing attacks and another 20 were captured on airfields in southern Iraq and in Kuwait. The IRAF lost a total of 142 aircraft[20] in combat and only one Coalition loss could be attributed to IRAF fighters.

With 36 kills and no losses, truly the F-15 Eagle had lived up to the dreams of air superiority advocates and those of its designers some 20+ years before.

LN
010

12

BURNING DEAD DINOSAURS: ENFORCING THE NO-FLY ZONES OVER IRAQ

OPERATION *SOUTHERN WATCH*

On June 14, 1992, LtCol Dennis G. Kremble led a portion of his 94th Fighter Squadron to Saudi Arabia. His was the first of 14 Langley jets to land at Dhahran that day. Having missed ODS, the "Hat in the Ring" Squadron was anxious for the chance to do battle with what remained of Saddam Hussein's air force. While victorious, the US had left the victory incomplete and the reign of Hussein was still in place. He had violently quashed Kurdish and Shi'ite movements for at least some autonomy and regional power, and his military, while badly beaten, remained whole.

In order to preclude IRAF participation in Hussein's atrocities against the ethnic minorities in Iraq conducted by the Iraqi army – such as Su-20/22 bombings of Kurdish populations near Kirkuk – the UN passed resolutions to prohibit military aircraft from flying in the southern half (south of the 32nd parallel that stretches across Iraq), and northern quarter, of Iraq. The southern version was named Operation *Southern Watch* (OSW), the northern Operation *Northern Watch* (ONW). While the Eagles patrolled the No-Fly Zones, Wild Weasels (initially F-4G/F-16 hunter/killer teams, later F-16CJs) were on hand for SEAD should Iraqi AAA or SAMs threaten, and strike aircraft (F-16s, F-15Es and RAF Jaguars and Tornados) were armed, airborne and available in the zones for retaliatory strikes should any component of the Iraqi IADS challenge Coalition air supremacy.

Integrating all these assets, plus tankers, AWACS, and reconnaissance platforms, required a centralized command and control element and thus the heart and brains of OSW air operations was the CAOC, which resided at the military headquarters in Riyadh until 2001. The CAOC generated the daily ATO for all Coalition participants, including those naval aviation assets and other aviation assets based in Kuwait, Oman, and other neighboring countries. It was staffed by a representative of each airframe, and each air force in theater. The F-15 CAOC representative worked exclusively for CAOC for 90 to 120 days and was usually a Weapons Instructor Course (WIC, the new name for the FWIC) graduate. This pilot was assigned to the CAOC independently of the Eagle squadron in theater and might not, therefore, hail from a squadron that was actually deployed. WIC graduates were preferred because they possess a much deeper understanding of how to coordinate F-15Cs in and among large strike packages comprised of multiple types. The CAOC often had to resolve complex tactical problems, which is an art that WIC graduates receive explicit training in.

All aircraft operating in the southern No-Fly Zone (NFZ) did so under the watchful eye of an RAF or USAF E-3 AWACS. The

OPPOSITE
The end of the road for the Eagle is drawing near, although its spectacular career is not quite over. Following Desert Storm, post-war draw downs and heartbreaking tragedy heralded the twilight of the Eagle's time in service. Today, USAFE's only Eagles are those of the 493rd FS at Lakenheath. (Steve Davies: www.fjphotography.com)

AWACS community fulfilled a number of roles, not only coordinating the efforts of the strike package and the F-15s protecting it, but also relaying instructions from the CAOC to the package; taking instructions from the Mission Commander (MC) and passing them to the individual elements of the package; and, of course, watching Iraqi airspace and the No-Fly Zone and warning of intruders.

The E-3 was key to the successful execution of each ATO because it acted as a communications relay between the CAOC and the MC. This was particularly the case after the introduction of a pre-planned retaliatory strike framework that allowed the No-Fly Zone enforcers to react to threats or incursions in a coordinated manner. This framework, later known as Response Options or ROs, replaced the largely ad hoc system that allowed instant retaliation but lacked the sophistication and effectiveness of SEAD/striker assets executing pre-planned attacks against carefully considered target sets. AWACS allowed the CAOC to action the strikers against a target or target set as it relayed the radio communications necessary to communicate the specifics of such a plan. It also allowed the MC to issue instructions to other aircraft in the package that were not on the same frequency – a common occurrence. Transmitting explicit plans in a single transmission to the numerous fighter controllers on the AWACS allowed them to then disseminate the relevant portions to the appropriate package elements.

The ATO would typically call for two Coalition strike packages per day, each as large as 50 aircraft. To protect them, six to eight F-15Cs would be launched, although the CAOC scheduled as many as 12 Eagles (out of a typical complement of 18) when IRAF activity posed a greater threat. Protecting all the strikers represented a significant challenge for two four-ships of Eagles. The level of threat posed by the IRAF was not so much in its physical disposition as it was the tendency to conduct harassment tactics at unpredictable opportunities.

Normally, the SEAD assets would accompany or follow the F-15s into the Area of Responsibility (AOR), and, once they were on station, the strikers were free to enter and roam the airspace inside the No-Fly Zone. The Eagle MC coordinated closely with the SEAD elements while his AWACS shepherded the other package elements. The Wild Weasels/F-16CJs worked closely with the Eagles in order to protect the integrity of the entire package, leaving the F-15Es to actually prosecute attacks against the pre-planned targets or to simulate such attacks when an RO was not being executed. There was significant freedom for them to investigate targets of interest and to engage in simulated weapons releases and attacks.

For the F-15Cs, however, OSW was all about prosecuting Iraqi aircraft violating the No-Fly Zone while simultaneously protecting all other friendly aircraft in theater, including tankers, reconnaissance, AWACS, J-STARS, helicopters, etc. Those who flew the mission characterized it as "maintaining the status quo," and that meant that the F-15C was the first to enter and the last to leave hostile airspace each day. This required close communication, as discussed, and careful fuel planning. Although this sounds rather elementary, it is a complex skill that was spurred by numerous instances in Operation *Desert Storm* when Eagles had to leave their CAPs or escortees because they had insufficient fuel to complete the mission.

Once on station, the F-15Cs would normally split into two-ship elements, with one going to the tankers to top off with fuel while the others maintained their CAPs. This would begin a cyclic sequence of on station time interspersed with visits to the "KCs" for gas. Meanwhile the E-3 AWACS kept a close watch on Iraq's major military airfields. On the rare occasion that an IRAF jet was observed to take off and turn south, the CAP closest to the Iraqi's anticipated penetration track was called upon to commit toward the would-be intruder.

Generally speaking, it was straightforward for both F-15C and the AWACS to identify intruders long before they breached the No-Fly Zone, although low-altitude contacts sometimes threw up false alarms. On one particular occasion an inexperienced AWACS controller called "bandits inbound" at "low-altitude and close range," precipitating a frantic intercept by the F-15s on the HVA CAP. Moments later they reported that there were no bogies in sight and it was later established that the AWACS' radar had used software logic to "guess" the position of an Iraqi fighter that it had lost track of. The fighter had actually landed, but the computer logic on the AWACS had continued to plot the "estimated path" of the radar contact over the NFZ and straight at the E-3 at low level. The controller had failed to recognize the situation and had certainly caused a few hearts to beat considerably faster.

Occasionally the IRAF would probe the No-Fly Zone, testing the Eagles' reaction time and observing tactics. The most serious possibility was that of the high-fast flyer: a MiG-25 that penetrates into the No-Fly Zone at Mach 2.5 and heads directly at a tanker or AWACS – both HVAs. This creates several problems and the Eagles must react quickly if they are to protect the HVA, as a result of which gaps in the CAP's protective screen can appear.

A very high value asset to be protected was the USAF U-2R very high-altitude reconnaissance aircraft operating over Baghdad. Sometimes the U-2s would originate in the OSW AOR, fly high (and exceedingly slowly) across Baghdad collecting critically important intelligence, and pass into ONW airspace in the northern part of Iraq. U-2 operations would prompt increased CAP missions in both AORs to protect the aircraft on ingress and egress. The slow speed of the U-2 made for long missions for both itself and its watchful Eagle protectors. On those occasions when the U-2 was returning to an OSW base, the F-15Cs had to remain airborne for periods of 10 hours or more, of which 8.5 were on CAP station.

OPERATION *NORTHERN WATCH*

On December 2, 1992, LtCol Douglas "Disco" Dildy led a portion of his 32nd Fighter Squadron "Wolfhounds" to Incirlik AB, Turkey, for Operation *Provide Comfort* (OPC). Initially OPC differed from the concurrent OSW in that the mission was to first provide sustainment – food, medicines, tents, bedding, warm clothing, etc., – to the Kurdish population in northeastern Iraq. This was delivered by truck convoy and NATO C-130/C.160 operations. To protect the convoys and Hercules flights from interference from the Iraqi army, overflights by NATO combat aircraft provided cover and an immediate response capability. Initially it was thought that multi-role F-16s could also provide protection from interference by Iraqi air force fighters, but after they missed an intercept the professionals were called in.

RIGHT
Flying a 32nd FS F-15A, LtCol Doug Dildy replenishes its fuel from a KC-135, high over the Iraqi desert. Tankers were considered high-value assets because they enabled the Eagles to stay on station and often provided the fuel needed just to get back to base, especially with the more fuel-limited MSIP-A models in OPC. Notice the pilot's stylish desert tan flight suit. (USAF)

ONW differed in the means, assets and ROE to achieve the same aim as OSW. It was an American-led NATO operation and as such utilized NATO AWACS (as well as USAF), RAF Harriers for close air support protection for the truck convoys, French Mirage F1CR recon assets for monitoring Iraqi army locations and movements, and USAFE Wild Weasels (81st FS from Spangdahlem AB) for SEAD and F-111s (later F-15Es) and F-16s for prosecution of the ROs when called for. Fortunately, the West's almost bloodless victory in the Cold War had rendered NATO QRA(I) superfluous and USAFE F-15C units became available to fly the NFZ enforcement and force protection missions. And of course, it was conducted from Incirlik AB, Turkey, the base of a NATO member.

Because of host nation constraints, usually the F-15 force was only six to eight jets. These would launch in two two-ships separated by two hours. The first two-ship would pass the AWACS and dedicated tanker en route and take a quick sweep of the AOR. Once assured that there was no IRAF activity in or approaching the AOR, they would go to the tanker and top off with gas. It was in excess of 400nm from "the Lik" (Incirlik) to the entry point of the NFZ and it would generally take about an hour to get there. The MSIP F-15As of the 32nd FS were weight-limited and to haul a full load of missiles were limited to two external tanks, so filling up with gas before the start of their "vulnerability time" was critical. The Eagles would then re-enter the AOR and make another sweep, and take a radar peek at the IRAF airbases closest to the NFZ line and call the area "clear" for AWACS to allow the SEAD, recce, and strike assets into the air space.

After about an hour it was time for another 'top off' and a quick visit to the tanker, which by now would have come down into northern Iraq, would replenish the tanks for the next hour on station, and the long trip back. The responsibility for the air policing would be passed to F-16s in the AOR, regardless of their tasked role in the ATO.

About this time the "Wolfhounds"' second two-ship would be launching at "the Lik" for the hour-long drive to the AOR. Upon arrival this formation would relieve the one that had been airborne for 3 hours and they would begin the long, boring trek back to the edge of civilization. If the replacement two-ship had a problem and aborted its mission, a third two-ship could be generated about an hour later, so the 4-hour ONW sortie would immediately be extended to 6 hours, and on one occasion, to an 8-hour mission covering six hour long "vul times" (vulnerability times).

After 165 days at Incirlik, the 32nd FS returned to Soesterberg on 15 May 1993, replaced by the 53rd FS "Tigers." The 160 pilots, maintainers and support folks returned home for a well earned rest, only to learn within the month that they would be closing the Squadron. The victory over the Soviets in the Cold War, and over the Iraqis in the Gulf War had significantly reduced the threat, enough to allow a major force reduction of US units in Europe, especially Eagle units.

THE PRICE OF VICTORY

In the early 1990s US Congress was looking for a "peace dividend" as the nation's reward for economically driving the Soviets out of business as a threat to the Free World. The Democratic Clinton administration harvested that "dividend" by severely reducing the US military. The USAF share of the drawdown acknowledged the decreased likelihood of challenging air-to-air opponents by reducing F-15 units first.

In PACAF, the 18th Wing was reduced from three squadrons to two with the 12th FS "flag" being arbitrarily moved to the 3rd Wing to subsume the historically Alaska-based 54th FS at Elmendorf AFB. Similarly at Eglin one squadron, the 59th FS "Golden Pride," was inactivated in December 1997 after sending its advanced, late model MSIP-Cs to establish an altogether new Eagle unit in England. However, typically, the "illustrious First Fighter Wing" suffered only a minor reduction in the number of jets on its ramp.

Quite naturally, USAFE took the brunt of the cuts. At Bitburg, the 525th FS "Bulldogs" (which had not yet converted to MSIP anyway) was the first to go, being closed on April 1, 1992, its jets being flown to Tyndall AFB to provide C-models for the FTU.[1] Shortly afterwards the decision was made to close Bitburg altogether and the 22nd FS "Stingers," the only 36th FW squadron to "miss the war" (because it was only partially through the MSIP conversion) redistributed its jets and closed as an F-15 unit early in 1994. On April 1 that year the unit "flag" crossed the Kyle river valley to take up residence at

ABOVE
Bitburg jets at Spangdahlem AB. Only the high scoring "Tigers" survived the USAFE drawdown of F-15 units, moving to nearby "Spangladesh" when Bitburg closed in February 1994. It took some time to adorn these jets with "SP" on their tails. (USAF)

Spangdahlem AB where the 81st "Wild Weasel" Squadron's closure left a vacancy on the ramp for a new squadron of F-16CJs. Meanwhile, the 36th FW was closed in February 1994 and Bitburg AB was turned over to the local German community for industrial and commercial uses. One was to use the serpentine taxiways through the Tab Vee hardened aircraft shelters as a go-kart track.[2]

Similarly, the 32nd FS "Wolfhounds" ended its long and pleasant association with the Dutch by flying its MSIP-As to the 101st FS, 102nd FW, Massachusetts ANG. The Squadron was closed on January 13, 1994 when the last three jets took off, and, being escorted to the English Channel by a pair of KLu F-16s, headed home to the States.

The 53rd FS "Tigers" was the only USAFE Eagle squadron to survive the peacetime obliteration of the force, moving its victorious MSIP-Cs to Spangdahlem AB to become a component of the 52nd FW on February 25, 1994. However, because a single dedicated air superiority squadron was not enough, especially considering the ongoing rotational tasking of ONW/OSW, USAFE received a second "new" F-15C unit.

The 493rd FS "Grim Reapers" was re-established as an F-15C unit on January 7, 1994, having been throughout its history an air-to-ground organization. Initially a dive-bomber squadron flying A-18s, A-20s and A-35s at the outset of WWII, it was redesignated the 493rd Fighter Bomber Squadron in August 1943 and flew P-47s in the ETO, being credited with 11 aerial victories as it stormed across France, Belgium and into Nazi Germany. Always a member of the 48th "Statue of Liberty" Group, it was re-activated for duty in the Cold War at Chaumont, France, in 1952, flying F-84F and F-86E fighter bombers. The unit was moved to RAF Lakenheath on January 15, 1960 and from there flew F-100s and F-4Ds in the nuclear strike role before flying as one of the Wing's F-111F squadrons between 1977 and 1992. The 493rd participated in Operation *Eldorado Canyon*,[3] the punitive raid on Libya that put leader Omar Khadafi in his place, and flew extensively in ODS in 1990/91. It was inactivated in December 1992 while the rest of the 52nd's squadrons transitioned to the F-15E Strike Eagle.

Like the 53rd, Eglin's two squadrons and Langley's three, the 493rd was heavily tasked in various contingencies before the post-Cold War world settled into a new global order. The unit achieved IOC on the APG-70 radar/-220 engine MSIP F-15Cs from the 59th FS at Eglin[4] on June 12, 1994, and between September the next year and OIF in March 2003 the "Grim Reapers" participated in 12 deployments to four different nations. As an illustration as to how badly the F-15 squadrons were stretched in this period, the 493rd made history in 1999 when it became the first USAF unit ever to deploy from one contingency theater to another, when six jets at Incirlik for ONW flew west to join 12 at Cierva AB, Italy, to begin Operation *Deliberate Force/Allied Force*.

In that conflict the unit performed supremely, obtaining four aerial victories. However, in the meantime the 53rd "Tigers" changed the reputation of the F-15 forever when two pilots – one of them the squadron commander – committed the most egregious and heinous of errors that a fighter pilot can make: fratricide.

BELOW
The drawdown of Stateside and USAFE Eagle units resulted in even Kadena's 18th Wing sharing the load of patrolling the No-Fly Zones. Here a fully loaded 67th FS "Fighting Cocks" F-15C blasts into the air from PSAB, Saudi Arabia. (USAF)

THE BLACK HAWK SHOOTDOWN

OPC operations on April 14, 1994 started at 06:35Z with the launch of two F-15Cs – TIGER 01 and 02 – on a sweep of the northern No-Fly Zone airspace, then transitioning into a DCA/CAP mission in the area. Twenty-one minutes later two US Army UH-60 Black Hawk helicopters took off from Zakhu, Turkey, near the Turkish border with Iraq. This flight was a routine trip transporting Turkish and UN officials into the Kurdish region of Iraq as part of supervising Operation *Provide Comfort*. They used their normal EAGLE 01 and 02 callsigns, and dutifully informed AWACS (callsign COUGAR) of their departure point and their destination. At 07:20Z TIGER flight entered northern Iraq, reported so to COUGAR and then began its sweep of the area, looking for Iraqi aircraft violating the No-Fly Zone. The OPC ATO never contained any detailed information about the Eagle flights, and this day the AWACS controller did not pass EAGLE flight's information to the F-15 pilots.

Two minutes later TIGER 01 reported a radar contact on a low-flying, slow-moving aircraft 40 miles southeast of his own position and approximately 52 miles north of the No-Fly Zone line. COUGAR, who initially could not see the low-flying helicopters due

BELOW
"Tigers" at "the Lik." Starting engines under the watchful eye of a 53rd FS crew chief, this F-15C's old radome contrasts with its newer Mod Eagle paint scheme. Not only is the radome in the original Compass Gray scheme, but is considerably faded by the sun and shows signs of several patches and spots of paint. In the background, 80-"balls"-4 (80-004) starts engines with a curiously light loadout: a single "bag of gas," two AIM-7s and two AIM-9s. Notice how huge the Incirlik 'third generation' Tab Vees are, compared to Spangdahlem's in the photograph on page 207. (USAF)

to their range and the UH-60s' terrain masking in the mountains of northern Iraq, responded with "clean there," meaning that the controller aboard the AWACS had no targets in that area. TIGER flight angled to the southeast to set up an intercept to investigate while simultaneously using AAI to interrogate the contacts for a friendly IFF response. In three minutes the gap had closed to 20 miles and TIGER 01 once again called the contacts out to COUGAR, who this time responded with "hits there," to indicate that he too saw the radar contacts.[5] TIGER 01 locked the target up and initiated his own IFF interrogations in both commercial and military (Mode IV) modes. Each six-second long attempt failed to elicit a response and TIGER 01 and 02 moved in closer to make a visual identification.

At 07:27Z, placing his wingman in a long trailing formation to cover him, TIGER 01 closed to 7 miles and visually identified the contact as a helicopter: "TIGER 01 is tally one helicopter, standby VID." He passed EAGLE 01 about 500ft high and 1,000ft to the left at 450 knots (EAGLE was at 130 knots), pulling off high and to the right. He observed that the helicopter was carrying sponsons carrying external stores, but was otherwise unable to see any distinguishing markings on the dark-green camouflaged helicopter. He radioed, "TIGER 01, VID 'Hind'... no, 'Hip,'" at 07:28Z, before referring to an in-flight silhouette guide to clarify his VID and then calling, "TIGER 01, disregard 'Hip,' VID 'Hind.'" With that he rolled out, headed northwest to reposition in trail with the targets and in doing so, looking down to the right, he spotted the second helicopter, trailing EAGLE 01 by 2 miles. "TIGER 01, VID 'Hind,' tally two, lead-trail" (at which time the generally clueless AWACS chimed in with, "Copy 'Hinds'"). Still in doubt however, TIGER 01 sought confirmation of his VID from TIGER 02, his squadron commander and a far more experienced Eagle Driver, having claimed a kill on a helicopter in ODS. The Eagle flight lead asked: "TIGER 02, confirm 'Hinds,'" and in response he heard, "Standby."

At this point TIGER 02, making his own VID pass, flew 2,000ft to the right of the trailing helicopter and transmitted, "TIGER 02, tally two." In the most tragic of miscommunications, TIGER 02 (later stated that he) only meant to convey that he had both helicopters in sight. Since this was in direct response to his query to confirm the VID, this was interpreted by TIGER 01 to mean that his squadron commander agreed that the targets were "Hinds." The use of the standard codeword "tally" to indicate "sight of enemy" instead of "visual" to indicate "sight of friendly or unknown aircraft" convinced TIGER 01 that his wingman confirmed they were enemy helicopters.

With that, the F-15 flight lead went into the well-practiced drill of prosecuting the attack. TIGER 01 transmitted to the AWACS: "COUGAR, TIGER 02 has tallied two 'Hinds,' engaged," as he headed 10 miles northwest, away from the helicopters, in a pre-arranged move to allow them time to get into position for a perfect stern attack. As he rolled back toward the helicopters he called: "TIGER [flight] arm hot, TIGER 01 is hot." He then transmitted on the Aux radio: "We're coming up behind them; there's two in lead-trail. TIGER 01 is going first, I will shoot the trailer and then you will shoot the leader." TIGER 01 and TIGER 02 used Auto Acq modes to re-acquire their quarry and attempted a final IFF interrogation before visually acquiring their respective targets in their HUDs.

TIGER 01 targeted the trailing UH-60 and launched an AIM-120 from about 4 miles out, calling, "TIGER 01, fox." As the Black Hawk exploded and crumpled to the ground, he added: "TIGER 01, splash one 'Hind.' TIGER 2, you're engaged with the second one. He's off my nose 2 miles, right past the fireball. Two call in. One's off left."

"TIGER 02 in hot." TIGER 02 followed with an AIM-9 fired from about 9,000ft at the remaining UH-60. The missile exploded on target and the helicopter wobbled momentarily before falling to the ground and exploding. "TIGER 02, splash second 'Hind.'" TIGER 02 gleefully reported the end of the engagement with the words: "Stick a fork in him: he's done!"

In those few moments the lives of 26 crew and passengers on two US Army Black Hawk helicopters were ended and the reputation of the F-15 Eagle was forever altered. Many factors contributed to the tragedy. The lack of awareness on the part of the AWACS controller resulted in a court martial. The lack of information in the ATO and Special Instructions ("spins") cost the career of a very talented, dedicated and conscientious brigadier general heading the OPC operation. However, the USAF failed to place the blame on the perpetrators of the event.

The F-15 pilots failed in a fundamental fighter pilot responsibility – to be able to correctly visually identify an enemy aircraft from one in their own nation's military – and miscommunicated the ID. Despite the fact that the squadron commander was the wingman (as was often the case in these normally dull and boring missions, the flight lead responsibilities were alternated to give the younger pilots more flight leadership experience), he set the tone in the squadron,[6] he failed to communicate his true (if later testimony is accepted) appreciation for the situation and, if he himself was truly unsure of whether the targets were friendly or Iraqi, he failed to call off the flight lead until the issue could be resolved with certainty.[7] At 130 knots the Black Hawks were still 40 miles from the No-Fly Zone line and were not headed there anyway. There was plenty of time to be sure, but no time was taken.

Even worse, the USAF handled the tragedy's aftermath appallingly. The two pilots were initially charged with court martial offences,[8] but rather than allow the merits of each participant's actions to be reviewed by a panel of judges – and thus the world, and especially the grieving loved ones of those who lost their lives aboard the helicopters – these were dropped by the commanding general, ostensibly because of insufficient evidence. In fact the two aviators were given normal, promising assignments for their next tours, until CSAF General Ron Fogleman stepped in and corrected the situation. In the opinion of many, the handling of the case's fallout was almost as much of a black mark against the Air Force as the tragic event itself.

The 53rd FS "Tigers" never fully recovered from the dark blemish on their otherwise exemplary record. The only way the USAF could make the issue and the pain go away was by closing the unit. This was done on March 10, 1999, leaving USAFE with only one Eagle squadron for the next war in its theater.

GROUND HOG DAY

For ten years USAF fighters patrolled the two NFZs over northern and southern Iraq. The repetitive nature of the flights, the abject monotony of the mission – simply being present in the area should an IRAF fighter attempt to enter the airspace – and the unending commitment to return again and again to do the very same thing over the very same terrain with no perceivable end in sight, led to a numbing of F-15 pilots' enthusiasm, motivation, morale and competence. The pilots referred to the ceaseless repetition of sameness as *Groundhog Day* after the Bill Murray movie depicting much the same mentality in a different context. The dull patrolling of Iraqi airspace – especially when the IRAF had atrophied to the point of being unable to mount a challenge to USAF fighters – became known as merely "burning dead dinosaurs" as the F-15s consumed copious amounts of JP-8 for no apparent payoff.

However, occasionally something would happen to snap the Eagle Driver out of his mind-numbed lethargy. Occasionally, and especially in the early years following the victory in the Gulf War, ONW/OSW missions drew a certain amount of ground fire from Iraqi AAA or SAM operators who operated in direct contravention of the terms of the 1991 ceasefire. Most AAA was considered ineffective below 15,000ft AGL and the Eagles generally "perched" in the mid-20s to avoid it, although unguided barrage fire was sometimes used to harass overflying F-15 formations. Radar-guided AAA or SAM launches were far more serious threats and simply a lock on by a SAM or AAA radar was enough to warrant a lethal RO. Since Coalition aircraft were roaming about the skies of southern Iraq armed to the teeth, someone was always at hand to deliver a striking blow. Normally the offending SAM site would be targeted but if that were not possible, dropping bombs or shooting HARMs at a known SAM or AAA site would suffice to demonstrate the Coalition's displeasure.

One of the more frequent Iraqi tactics was to launch a MiG and send it south to penetrate the No-Fly Line and then quickly reverse course and fly across a (to them) friendly SAM battery, hoping to lure the pursuing Eagles into that battery's lethal WEZ. Southern Iraq is a very large area and two or three two-ships of Eagles could not cover its entire expanse, so the MiG bait would be vectored by Iraqi GCI to a point in the No-Fly Line that would be relatively safe to penetrate. As soon as the F-15s came rushing to engage the intruder, it would turn away, running in a direction other than its home air base, but across the top of an alert and waiting SAM unit. This was called a "SAMbush."

Capt Nick Guttman deployed to OSW twice and on his twenty-third mission AWACS sent him and his wingman – who was on his first OSW sortie – to investigate a "track of interest," believed to be a MiG-29 on a test flight inside sovereign Iraqi airspace. Although this MiG-29 had not violated the No-Fly Zone the Coalition was keen to gather as much intelligence on the few "Fulcrums" that the IRAF was still operating, so Guttman's flight was dispatched to take a look. Upon committing to the track, the MiG promptly landed and Guttman and his wingman were illuminated and engaged by Iraqi MIM-23B I-Hawk[9] missile sites. Both F-15s immediately jettisoned wing tanks and broke away, returning to their CAP station. It was only after they had landed that Guttman had the opportunity to explain to his wingman, for whom this was his first combat mission, that OSW missions were rarely that exciting.

Guttman explained,

> I've had intelligence briefs every week for so many years where I've been told, 'the Hawk SAM can only reach such-and-such an altitude,' but when a Hawk missile was actually launched at me I had to keep telling myself that I was well above its maximum altitude because there was a big part of me that wondered if maybe, just maybe, they had got it wrong!

However, more commonly the missions were hours upon hours of dull, drumming boredom and the only exciting event was rejoining on the tanker to take on more fuel. In fact, the only legitimate training events that could be accomplished in theater were air-to-air refueling (AAR) requirements. Thus the pilot's combat skills – some form of which was normally practiced at least every other day at home base – naturally atrophied because none of the normal training events could be accomplished. The Turks prohibited training missions altogether and the fickle Saudi government dictated the number of continuation training sorties it would allow, depending upon the congeniality of relations between it and the US. In practical terms, that meant that unless an F-15C pilot was flying an OSW sortie, he was likely to be on the ground.

Guttman is a prime example: he spent 70 days at PSAB in 1998 and flew a meagre 21 combat missions (defined as missions into the AOR); he later accumulated only nine more combat missions in the eight weeks of a subsequent 2001 OSW deployment. From the moment the Eagle pilots arrived in theater there was a steady deterioration of combat skills until the day they left. Guttman summarized it succinctly: "You become adept at AAR, but you find that everything else goes out of the window."

Therefore, when a unit returned from ONW/OSW it was usually at a lowered "C-status" (the JCS reporting of Combat Capability in a quantifiable form) and after weeks away from families the pilots were called upon to undertake an increased training load to get them back up to speed. Beginning with 1 v 1 BFM and using a building block approach, the sophistication of the training was gradually increased to the point where pilots were once again able to engage in 4 v 4 ACT. Only once this was complete – several weeks later – would they once again be able to achieve the level of proficiency that they had had prior to their deployment.

However, sometimes these training programs were interrupted with short-notice deployments back "to the sandbox," usually to cover for a unit unable to make its scheduled deployment because of the flux of equipment exchanges previously described, or other real world contingencies, as in the case of the 493rd FS, mentioned earlier. This was because, prior to 1996, there was only a haphazard system in operation that allowed very little forward planning and was completely unreliable. It was not unheard of for an Eagle unit to deploy for what it understood to be a 45-day stint, only to end up staying for over 90.

AEROSPACE EXPEDITIONARY FORCES

The haphazard ad hoc scheduling of units into theater was wreaking havoc at all levels of squadron activity – personal, family, flying training, aircraft maintenance and leadership. As the solution, the Air Force developed the Aerospace Expeditionary Force (AEF). This was a force packaging and rotation road map that defined, 15 months in advance, which units would deploy to which locations. It was designed to bring some stability and predictability to the ongoing deployment mission and by and large improved planning conditions for all concerned. The concept established a consistent 90-day deployment cycle and planned on 12 months between deployments. While it was impossible – due to other unit commitments, force drawdowns, etc. – to make this work properly, it was a vast improvement over the haphazard and reactionary scheduling practices experienced prior.

Generally, the AEF concept had two effects, one good and one bad. On the good side, when the unit returned home, its members knew that they had a year of normal life, training missions and family stability before being sent off again. On the bad side, the knowledge that the unit would be going back in a year's time to the austere conditions and monotonous missions – and most of all absence from the family – drove many highly qualified F-15 pilots out of the few remaining active duty squadrons and into either civilian careers or the Guard.

Those young Eagle Drivers who went to ANG F-15 units soon found that due to the drawdown in active duty Eagle units, they were being "tapped" again for more time "in the sandbox." For example, the MOGAR had six operational deployments in ten years: Operation *Provide Comfort* (1996), Operation *Northern Watch* (1997 and 1998), Operation *Southern Watch* (2000), and Iceland (2001/2002 and 2006). Consequently, in a change from the historic longevity of being an Air Guard pilot, few of them completed more than three years flying Eagles in the ANG before departing the military altogether. Thus the continuous rotation of these disaffected F-15 pilots to ONW/OSW, without an end in sight, led to a large scale exodus of Eagle Drivers and a real reduction in the combat capabilities of the remaining F-15 squadrons.

While the constant rotations to the desert reduced the USAF fighter force's effectiveness, morale and man power, the constant oppression by Eagles enforcing the UN No-Fly Zone mandates eroded the IRAF to the point where it was a paper force only and had no residual combat capability whatsoever. The situation was so bad (for the IRAF) that when President George W. Bush decided to forcibly re-enter Iraq to remove Saddam Hussein from power in Operation *Iraqi Freedom* (OIF) all the F-15Cs conducting OSW missions were sent back to their peacetime bases to make more room for F-16s and F-15Es. There was no one left to fight in the air.

ABOVE
Engines run up and ready for brake release, MOGAR F-15A 77-118 prepares to launch on an OSW sortie. An A-model unable to take off with a full external load must leave something behind. In this case, the 110th FS elected to go with three "bags of gas," two AIM-7Ms, two AIM-120s and a pair of AIM-9Ms for maximum flexibility, if not maximum firepower. (USAF)

FF
0925

13

BALKAN KILLS

OPERATION *ALLIED FORCE*

From 1993 onward, F-15s supported a range of NATO and UN operations in the Balkans theater. In June 1991, the former Yugoslavia began its violent break up when the Republic of Slovenia and Croatia declared independence from the Federal Government in Belgrade. When civil war broke out in Bosnia a year later, the United Nations passed Resolution 757 introducing economic sanctions against Serbia and Montenegro.

Operations began in earnest when NATO and USAF AWACS aircraft began monitoring a No-Fly Zone over Bosnia-Herzegovina in October 1992 under the auspices of UN Security Council Resolution 781. Operation *Deny Flight* commenced on April 12, 1993, and involved a range of UN reconnaissance and fighter aircraft, mostly from bases in Italy, enforcing the No-Fly Zone. By July, F-15Cs from Bitburg's 53rd FS had flown over 660 CAP sorties protecting NATO troops on the ground in the Balkan regions of Banja Luca and Sarajevo.

On February 28, 1994, USAF F-16s downed four Serbian SOKO G-4 Super Galeb armed trainers as they violated the No-Fly Zone. Over the course of the year diplomatic efforts deteriorated, leading to a limited NATO strike against Serbian targets in Croatia, in particular Udbina airfield, in November 1994. The strike force of some 30 aircraft was protected by pairs of F-15Cs.

Operation *Deliberate Force* followed the August 1995 shelling of the market square in Sarajevo. Punitive strikes hit Serbian armor and supplies around Sarajevo on 30 August, once again protected from the Serbian air force by the F-15C. In the days that followed, similar protection was provided as the strikes became more widespread.

Operation *Allied Force* (OAF) followed repeated NATO warnings in 1998 to President Milosevic to remove his armed forces from Kosovo. Some 15 F-15Cs from the 493rd FS, 48th FW, RAF Lakenheath, England deployed to Aviano AB, Italy, in order to provide CAP support and OCA duties. NATO adopted a five-phase plan. Initially its military flights would act as a deterrent, becoming more aggressive if demands were not met.

Despite diplomatic gains made at the Rambouillet talks in France, additional NATO strike assets were still arriving in-theater as late as February 1999 and newly arrived F-117 "Stealth Fighters" displaced Lakenheath's Eagles from Aviano to Cervia AB. They were simultaneously reinforced to a total strength of 18 aircraft as jets were sent directly to Italy from a seven-week Operation *Northern Watch* deployment to Turkey.

Operation *Noble Anvil* – the name given to the US portion of OAF – kicked off on the night of March 24, 1999. The 493rd FS would claim four MiG-29s destroyed during the operation.

OPPOSITE
A 1980 artist's depiction of how AMRAAM would be employed in a multi-target engagement. Almost two decades later, Capt Jeff Hwang validated the concept by scoring near simultaneous kills against the Yugoslav air force. (USAF)

EAGLES CLAIM MORE KILLS!

In 1991 the Federal Republic of Yugoslavia (FRY) shrunk to less than one third of its original size following declarations of independence by Slovenia, Croatia, Macedonia and Bosnia and Herzegovina (it now consists only of Montenegro and Serbia). Following the cessation of hostilities and the subsequent Dayton Peace Accords in 1995, the FRY air force (FRYAF) reduced its inventory. By 1998, it had a mixed force of jet fighters on strength, including 60 MiG-21s, 16 MiG-29 "Fulcrums" and 60+ Orao ground-attack aircraft.

With the job of defending a landlocked country, the FRYAF knew that there were a limited number of routes that NATO could use without violating the sovereign airspace of neighboring countries, simplifying its air defense task. Like the IRAF almost a decade before, it enjoyed the protection of a multi-layered and mobile IADS, much of which was located in the mountains and was therefore very difficult for NATO to hit. This SAM threat worried the F-15 community more than the FRYAF itself.

The FRY government had no illusions about the fate of its MiG-29 fleet, were it to attempt to fight NATO head-on. However, it had struggled to maintain its fleet of "Fulcrums" even before the war, and knowing that a post-war Yugoslavia could not afford to keep them flying, it made a conscious decision to sacrifice its MiG-29s while protecting the remainder of its air force.

On March 24, 1999, LtCol Cesar Rodriguez, veteran of ODS and double MiG killer, claimed his third kill while flying OCA over the war-torn city of Pristina. He was No. 3 in a four-ship F-15 OCA force – KNIFE flight, mission No. 4125F – assigned to protect NATO's first strike package of the war. The package was targeted against Montenegro airfield, "and was also going to take out the EW radars that were linking the adjoining Kosovo/Montenegro airspace. We were to open up a lane of attack to make the province of Kosovo accessible without contention," recalled Rodriguez.[1]

KNIFE flight would lead everyone into battle – even the stealthy B-2s were scheduled to follow behind it. The mission commander that night was the F-16 lead pilot, LtCol Dave Goldfein; KNIFE would be lead by Robert "Cricket" Renner (the "Grim Reaper's" weapons officer), with "K-Bob" Sweeney at No. 2, "Rico" Rodriguez at No. 3 and "Wild Bill" Denim, a recently winged Eagle baby, at No. 4.

As the C-models took off at sunset, Rodriguez noted the eerie juxtaposition between the dark abyss – and war – to the east, and the sun setting to the west, bathing Italy in a beautiful warm light as the night life started up and people ventured into restaurants and bars for meals and drinks.

Having taken on fuel and positioned some 40 to 50 miles ahead of the main strike force:

> We flew down south along the Italian ADIZ, all the way down to "the boot" at the southern tip of Italy. Then we turned east, coming up along the eastern edge of the Adriatic. We pushed it up and began our climb to the mid-30s [thousand feet] with the strike package behind us.

Approaching the target area, Rodriguez's flight began to observe a contact which quickly landed before they could engage it:

> That airplane executes an instrument approach into Montenegro airfield and witnesses first-hand the destruction of the airfield. He may even have experienced a bomb or two himself as he probably did not make it to his hardened facility.
>
> As we continue to head north, "Wild Bill" and I are the eastern-most element, and we are looking at the airspace between Belgrade and Kosovo. "Cricket" and "K-Bob" are looking at Montenegro. I detect a target out of Kosovo airfield that initially heads north and stays at low altitude for some 15 miles. It then pops up on a southwesterly vector, putting him on a direct intercept with the strikers heading towards Montenegro. As he's turning to the southwest and climbing from a couple of hundred feet, we begin our initial intercept and start working with NATO AWACS for validation of identity and go through our own EID matrix.

The MiG had been detected and locked up at 19:09 Zulu, flying at 6,000ft, 40 degrees (right) and 62 miles off Rodriguez's nose.

OPPOSITE
Weapons loads depend upon several factors, but the early preference for four AIM-120s and four AIM-9s (pictured) had been superseded by the time the "Grim Reapers" participated in OAF. The more common loadout was now two AIM-9Ms, four AIM-120s and two AIM-7Ms. (USAF)

AWACS was unable to identify it as hostile at this stage, and 2 minutes later it beamed to a heading of 300 degrees, causing Rodriguez's radar to drop the lock. At the same instant, Renner (KNIFE 11) transmitted that he had an intermittent radar failure.

At 19:12.25Z Rodriguez reacquired the target and gave KNIFE 11 a bull's eye BRA report. At 19:12.36Z he asked AWACS to declare his target, but received a "bogey" reply; AWACS was not yet sure. Less than a second later, KNIFE 14 transmitted that NCTR indications in his cockpit indicated the target was a MiG-29. Still waiting to engage, and now down to 30 miles separation from the target, Rodriguez, "jettisoned the wing tanks so that we could go a little bit faster, climbed to about 33,000 and accelerated to Mach 1.4." At 19:13.25Z he then fired,

> a single AIM-120 against the single contact. The missile comes off the rail, jets out in front of me and then selects a lead pursuit curve commensurate to a positive intercept. We execute an F-pole [19:13.27Z] to the southeast so that we can avoid going into the Kosovo SAM belts, and then track the missile toward closure.
>
> Still 15 to 16 miles away, I come back pure pursuit to assess the missile's status and everything is going well, so I stay on course [and wait for the timer to count down to zero]. The MiG was obviously still full of gas because as the counter hits zero [19:14.06Z], there is a phenomenal explosion. If you put several football fields together and light them up all at the same time then that's what it looked like. The intercept happened over the western mountains of Kosovo and they were still covered with snow – the reflection of the explosion off of the snow had the guys on the strikes well south of Montenegro wondering what the hell we had hit.

Capt Mike "Dozer" Shower was the second "Grim Reaper" to score a kill that night. He recalled:[2]

> The flight line was completely still and quiet when we stepped to the jets, it was a somber moment. I'll always remember handing my name tag to Sgt Donald Green, aircraft '159 crew chief. I really don't remember much of what was said, it was pretty emotional, but I think it included "bring my jet back and you with it." I taxied and took off first since I was leading the first four-ship out. Our package had a greater distance to travel before our push time. We took off at sunset, one at a time (it was a tiny runway), and I'll never forget it because there must have been 100 personnel lined up along the infield down the runway standing at attention when we took off – it sent chills down your spine. The line-up was myself as EDGE 61 and "Man-O" Steele as my number two. The second element consisted of "BillyMac" as number three with "Dirk" Driggers on his wing. We used most of the Squadron during the first 24 hours, including our newest wingmen. "Dirk" was one of these, with only a few hours of night in the Eagle, not long out of RTU, and here he was in the first four-ship, at night and at war over hostile territory – it was great! While they were nervous, they did a fantastic job hangin' in there. In fact, I was most impressed throughout the entire conflict by how well our young pilots performed. They followed their training to a "T" and in many ways performed better than us more experienced pilots did.
>
> "Cricket" Renner was leading the second four-ship to take off. My four ship was tasked to protect a US-only package consisting of ten F-117s, two B-2s on their combat debut, four F-16CJs and two EA-6Bs over northern Serbia. "Cricket" had a Coalition package of aluminum aircraft [non-stealthy] pushing first into the Kosovo province and southern Serbia.
>
> The northern push was considered the "low-observable stealth" package and since it was US-only, the NATO AWACS was not well informed of its presence, purpose or composition. This was not great planning or coordination on the Coalition leadership's part. Out of many painful lessons learned a few were that you might not want to plan that the war will only last a few days and it might be wise to bring in everything you need to fight – like a US AWACS to control your US-only packages! In fact, when I checked in with the AWACS, they said in effect, "Who are you?" so we were off to a rough start and this had a significant impact on our mission. The package marshalled over Hungary and then was to push south thru Serbia towards Belgrade. The B-2s were moving from south to north throughout the country so they were really under everyone's protection during the mission. The F-117s were doing their "spider routes," going all over to their various targets in north Serbia. Our plan was to sweep the area as two two-ships separated by about 25 miles, then set up two CAPs just north of Belgrade facing south. This would keep us out of the SAM rings but give us good coverage of their known MiG bases. I was holding down

ABOVE
Such was the dominance of the Eagle and the skill of its pilots, that there was a preference to take the fight to the enemy in the night time, when the overwhelming technological advantage of the Allied forces could be used to exacerbate the enemy's weak night flying skills. (Gary Klett via Steve Davies)

the western CAP with two, while three and four held the east CAP. With all this going on, and NATO AWACS not being in the loop, it made for a real mess.

Since we didn't have NVGs yet, our formation within the elements was about a 5-mile trail for the wingmen. They maintained this using the radar, TACAN and the IFF interrogator, as well as having built in altitude deconfliction between aircraft. Since we were a little short of AIM-120s, some of the aircraft had six AIM-120s, and some had four '120s and two AIM-7Ms. All had two AIM-9Ms, three bags of gas and full chaff and flare. My aircraft had the two AIM-7 configuration along with the AMRAAMs. The heavier AIM-7s were on the front stations with AMRAAMs behind them and on the inboard wing stations.

We pushed first, about two minutes in front of the CJs as planned. This gave us room to pump cold [turn away from the bad guys] once and not run over the CJs. It was a crystal clear night, we could see all the way to the southern end of Serbia. The lights of Belgrade were right there to the south. Since we knew the timeline, as the TOT [time over target] for the initial wave of cruise missiles came close, I had the whole flight look south at Belgrade. We could see the orange glow of the explosions as they hit various targets. Then it was our turn, and we pushed south.

We were in the mid- to high-30s [thousand feet] and the CJs were in the 20s. The F-117s were below them and the B-2s came through way above everyone. This gave us some concern, having JDAMs coming down through us, but it was "big sky theory" in such a tight airspace. We were really stuck, we didn't know where they would be, we had no way to see or avoid them and we had to stay close to the MiG bases. I had briefed the '117 weapons officer that if we engaged low targets we would shoot and dive through their block. He said he was fine with this, after all, "it's a big sky theory!" More about this later!

We had just gotten to the southern end of the CAP point and were getting ready to set up our counter-rotating CAPs when I hear the call "Splash one MiG in the south" relayed via AWACS. This was the luckiest guy in the world. "Rico" now has his third MiG kill. So we were pretty fired up now, we knew they were flying. We had questioned whether they would fly or not, and now we knew the MiGs were up. We were running 10-mile legs in the CAP and we had been in-country for roughly 6.9 minutes. I turned south again for the first time and just like that, at 35nm, there's a blip on the radar. I lock him up, and he's doing 150 knots at 1,500ft, climbing out from their airfield in Belgrade, Batajinica. I call everyone, "Heads up, contact out of Batijinica." There's no ID or AWACS calls yet and I break lock and go back to search. A short time later the radar shows him northbound so I lock him again at 25 miles, our briefed lock range. Now he's at 10,000 going 400 knots.

Unknown to me until after the sortie, most of my radio calls on my main radio were unreadable. The radio was jamming itself, but I didn't know it, there was no feedback in the headset, all we heard when playing the tapes together after the sortie was silence on everyone else's tapes while I was jabbering away on the radio on my tape. So almost all of my contact calls, IDs, shots, etc., were not heard by anyone but me. This will turn out to be a huge factor in the chaos that ensues.

By 17 miles I have an ID that this is a bad guy, and I call it out. I talk first and shoot second, just what you're not supposed to do. So I call: "Hostile, hostile, Fox 3" and take my first AIM-120 shot at 14 miles. I made sure the AIM-120 was active and then thumbed to, and shot, an AIM-7. No kidding, I've always wanted to shoot an AIM-7, and that big ol' Sparrow comes off, whoosh! I'm looking down into the lights of Belgrade so I can't see anything, but I was able to follow the missile motors for a while. I'm ramping down from 37,000ft the whole time. At about 6 miles, and just after the AMRAAM times-out, the target turns right, directly into the beam. This could have been triggered by several things. He could have gotten indications of my radar lock, the AMRAAM could have exploded near him but not damaged him, who knows, but he does maneuver into the beam. So now he's maneuvering when the AIM-7 gets there, and it apparently misses also.

Now I'm at 5.5nm, look-down, when I shoot another AIM-120 and call "Fox 3 again." I'm at about 20,000 and he's at about 10,000 and I'm diving. This missile comes off and goes about straight down, and I'm diving and turning left looking down trying to follow it. The MiG then comes out of the beam in a climbing left turn toward me, kind of breaking up and into me. Maybe he got spiked, got a call from his GCI, or just looked up into a dark sky and saw the missile, but we end up about 8 or 9 thousand feet apart, he's almost directly under me, head to head aspect. I pick up a spike (I have no idea where it came from – I never looked) and at the same time I'm glued to the missile motor when it turns into a fireball. Of course, I'm supposed to be in Auto-Guns and clearing for other bad guys. Instead, I'm in a steep left turn staring at the fireball thinking, "cool!"

I don't see an ejection but there was a lot of stuff coming off the aircraft, I watched it impact the ground. We found out later that the pilot actually survived, which I was really glad about. My goal was to shoot down the aircraft, to eliminate a threat to our aircraft, you really don't think about killing the other guy. In hindsight I was glad to have only shot down the aircraft: he had a wife and kids too.

Remember what I said about the F-117s and the "big sky theory?" This is exactly where this proved false – as always, Murphy's alive and well. Because we had spun once in the CAP prior to the commit, one of the F-117s was now in front of us, directly between us and the MiG during the engagement. He's flying along looking through his NVGs when, whoosh! whoosh!, two missiles go right over the top of his canopy. He looks back and forward and realizes he is sandwiched, smack in the middle of an air-to-air engagement. I'm 20 degrees nose-low, and about a 30,000 away from the F-117, pointed right in front of him, when I fire my third missile. I find out by talking to him on the phone later that he sees all this as the missile motor illuminates my F-15, and the missile, followed closely by me, flies right across his nose. I almost hit him. He turns and follows the missile's path and sees the MiG turning left toward him also! Then the MiG explodes and he watches it crash too. Another '117, about 35 miles away, sees the explosion. With his NVGs he clearly saw the MiG, the Eagle and the '117 all together. So much for the "Big Sky Theory," and of course, I have no idea this just happened!

While all this is going on, my wingman and other flight members are only getting bits and pieces of my radio calls. He knew something was going on but not the whole picture. Because of this, when he sees the fireball, "Man-O's" first thought is, "'Dozer' just got shot down!" I then transmit on the other radio "Let's come off north," and he thinks, "Thank God it's not 'Dozer!' He did have an ID by then and was ready to shoot but held off on his shot trying to figure out what was going on – outstanding patience for a young fighter pilot at night, on his first combat sortie! The other element didn't realize what had happened until later (radio again). So that's the end of the first engagement.

We had just reset in the CAP when we turn south and see an exact repeat of the first radar contact, except at 20 miles this guy turns into the beam. I can't get an ID on him and AWACS is no help, not once did they call an ID on a real airborne contact that night in the north. I can't blame them entirely because first, NATO AWACS did not train

BELOW
Bitburg's 53rd FS "Tigers" conducted combat air patrols over the restless Balkans region during the early 1990s. (USAF)

Capt Montgomery
Snooze
4006
PUSH

as focused on tactical engagements as US AWACS controllers did and second, they were not given our US-only ATO so they didn't know who was where, at what altitude, times, etc. In addition, since they couldn't hear my ID and shot calls either, there was no way for them to hold onto a contact and pass the ID back to us if we lost track or had to turn cold (again a factor later on). At this point I end up right over the top of the contact, I'm at 30,000 feet and he's at 10,000. I call my element out north since I don't have an ID and no NVGs, so we're not comfortable running on him. In my heart-of-hearts and based on information I had in front of me, I knew this was a hostile, I knew where everyone else was (Eagles and CJs, and I knew he wasn't a F-117 or B-2), but without the technical and "legal" ID I couldn't shoot.

After the shoot-down of the Black Hawks, the F-15 community was so conservative and worried about doing something wrong, that we missed an opportunity to do something right. While being conservative is a good thing, we completely removed the ability of a pilot to use common sense and situational awareness. I had no doubt who this guy was, I had tracked him off his airfield. So while I did the right thing, what if the MiG had gotten a lucky contact and shot one of us? I fully believe I would have been questioned for not shooting. In retrospect, and I teach this all the time now, under the same circumstances – shoot! If there's any doubt you don't hit the pickle button, but if there isn't, don't be a lawyer – do what's right!

Meanwhile, "BillyMac" and his element are running on this guy, who is now northeast of Belgrade turning back to the north. "BillyMac" runs on him for 30 miles with a lock and he can't get an ID. One of the problems is while I was directly over the top of the MiG, "BillyMac" gets a "friendly" indication from our merged plot. I didn't think to call out that I was directly over the MiG and he doesn't know to break lock and re-acquire to clean up the picture – in those days we didn't have data link so we didn't have great SA on where other people were. They go in to 10 to 15 miles and abort out for lack of ID. Meanwhile, "Dog" Kennel, an F-16CJ pilot, CLUB 73, has a solid radar lock on the MiG but no ID. He asks me seven times to confirm "spades" on the target (lack of friendly IFF), but once again because of my radio he can't hear me (I respond five times to his calls!). In the heat of the battle he forgets to then get an electronic ID so he holds his shot and comes off north with "BillyMac's" flight.

With no one able to get an ID we now have eight fighters all running north away from one MiG-29 because we couldn't ID him or use situational awareness to shoot him. While we are bravely running away to the north, my two ship is in a position to start a turn back to the south to look at Belgrade again. Right then AWACS calls out, "MiG-29 CAPs airborne near Belgrade," so I'm thinking about where did all these MiGs come from? We found out just before take-off they had moved six MiGs well to the south (the ones "Rico" engaged) but what AWACS was calling was ground traffic. We flew south all the way to Belgrade looking for these MiGs that weren't there. (They became somewhat infamous for this. Worse were those in charge at the CAOC that several times attempted to commit us through SAM rings throughout the conflict to attack MiGs that weren't there, because they were ground tracks.) OAF took a big step toward centralized control and execution.

A few minutes later the lone MiG-29 had turned south, so the other six US fighters turn and start chasing this guy south. "Dog" calls me and recommends that I turn north. As soon as I do, I get an immediate radar contact with hostile ID at 16 miles, beak-to-beak. "Man-O" is with me and locked also. At the exactly same time that I call the Bull's Eye position of the hostile contact at 10,000, AWACS comes back with, "Friendly there, 27,000." So I start a steep dive from 37,000 trying to get below 27,000, all the while screaming for the position of the other Eagle element and CLUB flights, the CJs. Of course they can't hear me because of the radio issue, so I get no answers from anyone!

By the time I'm diving through 19,000 the MiG is now five miles off my nose and I know I'm looking at a guy well below 270. I call, "Hostile, Fox 3," and shoot one AIM-120. I make a cardinal mistake here and its something I always hammer guys on doing – take two shots! They are called "miss'iles, not 'hit'tiles." So, I hold the second shot since I only have one '120 left and an old AIM-7. I should have cranked [F-poled], which would have given me room to complete the intercept and be in a position to shoot again (another mistake), but I don't, so I'm in a right turn looking straight down when near time-out I see a small "pop." This could have been a proximity detonation of the missile or it could have been the missile hitting the ground. Either way, it didn't down the MiG and there's no fireball, so my "one" shot didn't do the job. Now I'm too close to keep him on the radar so he gimbals off my radar low, so I'm looking all the way down and he's got to be right under me and I'm thinking this isn't a very good situation. So I've got to spin to get spacing and hope he ends up in front of me again. I call for a 360 turn or "spin" and around I go. I say "I" go because of the radio again, two doesn't hear the call.

"Man-O" has been locked to this guy the whole time, but he doesn't hear my hostile call, my shot, nor the spin call, he also doesn't have his own ID so he's not sure who this contact is. While I'm in my 360 turn I see the air-to-air TACAN range getting bigger so I ask him for his heading in the other radio and he says, "south." I direct him to come north and spin to get back in formation, and being a good wingman, he drops the contact and turns north. Had I known he was tracking the same contact and in a position to kill this guy, I would have shouted, "Shoot him, he's hostile!" In fact, when we listened to his tape later there was broken but audible radio calls from "Man-O" about being locked to something – had I been able to process that and figure out what was happening, we might have been able to get this MiG.

Once I roll out southbound and "Man-O" is back behind me, we get more locks on a contact that we know is the same guy, he's heading south towards Belgrade, same place we left him, same airspeed and altitude, but I can't get an ID and AWACS keeps saying, "friendly there," so I can't shoot. No kidding, this is the only radar contact in the area, everyone else we can "see" with radar and IFF is behind us (ie it was only stealth aircraft in front of us and the MiG). He starts to slow and descend so I secretly hope he has battle damage and is going to crash, but he was probably on approach to his field. We are coming up on the SAM threat rings around Belgrade and I don't want to go from hero to zero by getting us shot down so I drop the contact and call us out north. We missed killing this guy not once, but twice, for a variety of reasons. My radio problems, ID issues, not shooting two missiles, AWACS not hearing the hostile calls, the reasons mentioned before, all compounded in the "fog of war" to cost us this opportunity. And many of the issues were solvable at the time had I just been able to process the information and act upon it.

However, at this point we just return to our CAP, the B-2s are nearly overhead based on timing and it's time to egress and RTB.

All said and done, it was still a pretty cool start for Eagle drivers on the first night of a war!

MULTI-TARGET ENGAGEMENT

The final two kills for the 493rd came courtesy of Capt Jeff Hwang on March 26, 1999.[3]

Hwang was tasked as the Bosnia-Herzegovina DCA flight lead to provide cover for a vulnerability time of 15:00Z to 19:00Z. He and his wingman were eastbound approaching the Bosnia/Yugoslavia border having established their orbit over Tuzla following initial refueling, when he picked up a radar contact 37 miles to the east, at 6,000ft, beaming south at over 600kt. The time was 16:02Z.

Hwang called out the contact and "Boomer" McMurray, his wingman, confirmed that he saw the same on his radar. Unable to immediately EID the contact and with AWACS unable to see it, Hwang elected not to cross the border but to enter a right hand turn to run parallel with it on a southwest heading. He simultaneously called, "Push it up! Burner! Tapes on!" to accelerate the flight from its leisurely .85 Mach at 28,000ft to just below the Mach.

He continued his run for 60 seconds (10 nm) before directing the formation to turn back hot, coming through south to east in an attempt to get some cut-off on the contact. "Boomer" McMurray was on the north (left) side of the formation and both he and Hwang picked up the contacts once again at 070 degrees, 37 miles, 23,000ft, now heading west, straight at them.

Hwang was convinced that the contact was a FRY fighter because of its location and the fact that there were no NATO OCA missions over the border at that time. He checked for friendly IFF signals but received no reply, so he called AWACS and asked for permission to engage. AWACS failed to respond, although it had just begun to detect the westbound contacts on its own radar. Accordingly, DIRK flight continued using its own EID matrix as the contact closed to within 30 miles, to classify it as a hostile MiG-29.

As he secured the EID, Hwang called on "Boomer" McMurray to maintain the lock while he went back to search mode and began to sanitize the area around the contact for any trailers. The target turned to the northwest and descended to high teens (thousand feet), so DIRK flight checked 30 degrees left to the northeast to maintain the cut-off. Having been momentarily placed behind McMurray in the left turn, Hwang repositioned himself in line abreast and then called for jettison of the flight's wing tanks.

Now well above the Mach, Hwang positioned his radar elevation coverage to look from 5,000ft to 21,000ft in an effort to make one last sweep for trailers or other unseen contacts. AWACS simultaneously started calling out two contacts in a lead trail formation. Sure enough, he could see on his scope that his radar was just beginning to break out a second fighter in very close formation with the first. With the distance closed to some 20 miles and the contacts at 18,000ft, McMurray called, "Fox 3," as he unleashed an AIM-120 AMRAAM.

Hwang locked up the leader at about 17nm, immediately thumbed forward to his high-data Track While Scan (HDTWS) mode and then shot his own AIM-120 inside of 16 miles. He immediately stepped his acquisition cursors to the trailing "Fulcrum" and pushed the pickle button to command a second AIM-120 on its way. Hwang was about to score the F-15's first ever multi-bogey, double MiG kill.

Assuming that McMurray had locked the leader, Hwang kept the trailer as his primary designated target. He stayed in HDTWS as the slant range closed to less than 10 miles. Both targets started a check-turn to the southwest and continued to descend to low teens. DIRK flight checked their RWRs to make sure that they were not being targeted, and then pointed their noses straight at the MiGs, assuming a pure pursuit curve. They rolled inverted from 30,000ft and pulled their noses low and directly at the TD box in their HUDs.

BELOW
One of the MiG-29s downed by Hwang split into two pieces and pancaked into an open field. Several of the MiG's air-to-air missiles remained intact, with the post-crash fire being limited to the aft fuselage section. (US DoD)

Pulling the throttles to idle, Hwang saw a tiny dot in the TD box about 7 to 8 miles out against a broken cloud background. He called, "DIRK 1, tally-ho, nose, 7 miles, low!" Realising it was the trailer, he waited for McMurray to call that he had the leader in sight. Approaching 5 miles and with no call from McMurray, he scanned without success in front of the trailer for the leader.

The trailer continued its left turn to the southwest when Hwang thumbed aft to AIM-9 and tried twice to uncage, only to discover that there was no missile tone. At that instant, between his HUD and canopy bow, he saw the leader explode spectacularly at his 1 o'clock position. Turning his attention back to the trailer, it too exploded into a streaking ball of flame seconds later.

Hwang called for McMurray to assume a 080 heading and run his short-range search mode. He thumbed aft to Auto-Guns and plugged in full afterburner to accelerate to 460 knots and climb back to 20,000ft. DIRK 2 then called, "Blind!," but DIRK 1 quickly located him visually, 3 miles north (left) and stacked high. Waiting a few moments to check one last time for any more hostile fighters to the east, Hwang and "Boomer" McMurray began a hard turn to the west and departed the area.

Hwang had flown a well-executed intercept according to basic USAF doctrine: maneuver for displacement; check EID; shoot; F-pole and displace again, or go pure pursuit if target falls within 10 miles; enter BFM if required. His decision to follow his AIM-120s to the target instead of F-poling was influenced by two factors: firstly, he was winning the fight – at least he was not being fired upon – and secondly, he had closed to within 10 miles of his foe and was committed to the engagement.

It was later determined that McMurray's AIM-120 had failed to hit its target. Hwang's near simultaneous multi-bogey AIM-120 engagement had brought down both "Fulcrums."

OPPOSITE
AMRAAM and MSIP combined just as planned to give the Eagle an even greater advantage over the enemy. Although the Yugoslav pilots were braver than those encountered over Iraq almost a decade before, they were still hopelessly outclassed. Once again, the F-15 had proved that it was in a class of its own. (Tyson V. Rininger www.tvrphotography.com)

CHANGING TIMES

OAF signaled that the Eagle had truly evolved through three eras of potency and lethality. First, the F-15A with its AIM-7F and stern-aspect only AIM-9J and -9P; then the non-MSIP F-15C with its "leftover" AIM-7M and AIM-9L; and finally, the MSIP F-15C with the AIM-9M and multi-target-capable AIM-120.

The AIM-120 AMRAAM had superseded the AIM-7M Sparrow in late 1991 (in fact, Chuck Magill had flown the first operational

BELOW
Whereas the USAF's involvement in the 1991 Gulf War led to multiple C-model Eagle squadrons being deployed to the region from the continental US, patrolling the skies over the Balkans was largely the sole domain of Lakenheath's "Grim Reapers" – a role the squadron performed with alacrity. Lakenheath's four squadrons of F-111Fs departed the UK following the 1992 arrival of the Eagle's beefed-up, air-to-ground optimized younger brother, the F-15E Strike Eagle. Two squadrons of F-15Es were in place by the time a third former 1-11 squadron, the 493rd FS, was reactivated in 1993 to host the F-15C/D. The Grim Reaper's arrival resulted in a hastily redesigned patch: gone was the prominent "blivet" from the F-111 days, and in came a skull with crossed lightning bolts piercing the eyes. Above the skull was written in Latin "Mors Inimcis," which translates roughly as "Enemy of Death." The one remaining 1991-era 48th TFW Aardvark squadron, the 495th TFS, has never been reactivated; Lakenheath retains just one Eagle, and two Strike Eagle, squadrons. (Steve Davies: www.fjphotography.com)

LN
493 F
AF84027

F-15 AMRAAM sortie at the end of Operation *Desert Storm*), paving the way for some dynamic and exciting new tactics to be developed. AMRAAM required the shooter to support it only until such a time that its own onboard active seeker could acquire the target, at which point the shooter was free to leave the area. It used a secure data link with the launch aircraft to report its position, allowing for accurate fly-out indications in the shooter's cockpit, therefore allowing him to know where the missile was relative to the target.

But AMRAAM requires a good radar to support it, so the APG-63's constant development and investment is equally as important as the emergence of the missile itself. Indeed, Hwang was able to engage two targets simultaneously from TWS mode only because the radar in the nose of his fighter was now good enough to accomplish such a feat – a capability that Eagle pilots could only have dreamed of during ODS.

For all of those advancements, the core onboard EID capability was almost certainly the key ingredient once again in all four engagements, particularly Hwang's double kill. The performance of the NATO AWACS in OAF both in human and technological terms has been heavily criticized. AWACS controllers consistently underperformed and failed to provide timely clearances and advisories when the Eagles needed them most. Two examples include Hwang's later recollection that he was sure that he did not get a response from AWACS to his coded request for permission to engage, simply because the controller was unfamiliar with the codeword that he used; and Rodriguez's observation that some AWACS crews underperformed by a significant margin and did little to inspire the confidence of the OCA and DCA CAPers. He said of the NATO AWACS controllers: "they were ill-prepared or ill-trained to meet their role in the ID matrix."

Some things had remained unchanged over the years, however. Of particular interest is that the formation flown by the 493rd FS in their night sorties was similar to the off-set trail that Graeter had opted for on the first night of ODS. Some F-15 squadrons had night vision goggles by 1999, but the "Grim Reapers" had yet to receive them – they therefore chose to fly the tried and tested "defense in depth" (DnD) formation. "DnD" allowed the supporting two-ship element flying 25 miles in trail to kill the target if the first element was unable to do so itself. In such a scenario, the first element would disengage and flow in behind the second element in what resembled an airborne wagon wheel. Like off-set trail, defense in depth not only alleviated the second element's position-keeping workload by making use of the radar to help keep correct spacing, but also permitted the No. 2 and No. 4 to trail some 3 to 5 miles behind No. 1 and No. 3.

LN
AF
84
010

14

THE EAGLE'S FUTURE

The F-15 Eagle has led a distinguished career that has now spanned more than 30 years. It is inevitable though, that as advances in technologies proceed apace, the Eagle begins to look more and more like a legacy fighter.

The Air Force continues to modernize the Eagle where cost permits, however. FDL was installed in 2002, a device that enhanced SA by an order of magnitude, and from 2005 the first Eagle units started receiving the Joint Helmet Mounted Cueing System (JHMCS). Although the IAF has been using the DASH HMD (helmet-mounted display) in its F-15 squadrons for many years, the USAF was comparatively slow to adopt a helmet-mounted sight, and only began testing JHMCS in the F-15 in May 1999. JHMCS takes information that is normally shown on the HUD, VSD and TEWS display and projects it onto the inside of the pilot's visor. In doing so, the pilot can see all of the key information he needs to fly, navigate and fight without having to glance inside the cockpit or out through the HUD. The helmet also allows the Eagle pilot to cue the high off-boresight (HOBS) seeker head of the new AIM-9X visually, and is crucial if the new Sidewinder's WEZ is to be fully exploited. JHMCS allows the TD box to be displayed anywhere within the radar and AIM 9's fields-of-view, rather than being confined to the relatively small area that is the HUD combining glass.

According to Capt Greg "Lava" Moulton, who was flying the most advanced Eagles in the inventory at Elmendorf AFB, Alaska, in 2006:

> Two-ship visual maneuvering against one or more adversaries is where the JHMCS and 9X really make their money. These two systems in conjunction give you the capability to kill the bandit anywhere in the HOBS arena, and thus leveled the playing field of the MiG-29 "Fulcrum" and the infamous AA-11 "Archer." In a visual fight, I just have to place the bandit under the aiming cross in the helmet, consent to track the 9X seeker, listen for a valid tone, and shoot. He's dead.

Additionally, the TEWS can pass threat warnings to the Eagle pilot via the JHMCS visor, making it simpler and quicker for him to get "eyes on" a bandit or SAM system before, or as it shoots at him. Various declutter options allow the pilot to reduce the amount of symbology that is displayed to him, and he can also program it to remove all symbology when he looks down into the cockpit or through the HUD.

Elmendorf's 3rd Wing operates Eagles with the APG-63(V)2 AESA radar.[1] The wing's two squadrons each operated a mix of (V)1 and (V)2 radar jets on a ratio of about 2:1 to enhance flexibility. When paired with FDL, this enables a flight leader to

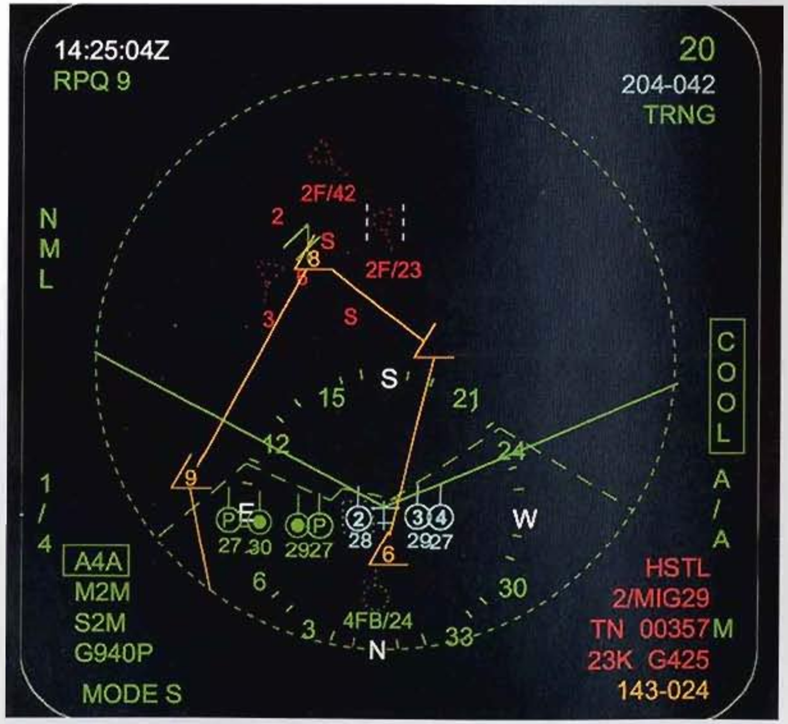
OPPOSITE
A beautiful sight to behold, the Eagle exudes class and an unspoken superiority unlike any other modern fighter jet. Someone once said that if a fighter looks good it'll fly well; there are few better examples of the truth of that than the F-15 Eagle. Only showing its age when compared to the computer-designed F-22A Raptor that will replace it, the Eagle is destined to go down in the annals of history as one of the all time classic fighter jets. (Steve Davies: www.fjphotography.com)

serve as the "mothership" with an extremely long-range look, and feed the information to the rest of his formation. FDL was a follow on to the MIDS of the mid-1990s and finally reached the Eagle community in 2004. FDL uses the MPCD to present a top-down digital picture of the battlefield.

To put it into perspective, Moulton explained:

> During Tactical Intercepts and 2 v 2 or more ACT is where the V(2) Radar and FDL make their money for us. Because the (V)2 is an AESA radar it isn't limited by a hydraulically swept radar dish. This means it has an almost instantaneous update rate and can track and target multiple bandits simultaneously, and using FDL to pass this SA to the rest of the formation it is a force multiplier and makes intercepts that much easier, especially when out numbered by two to one or more.

The results of the 3rd Wing's "light-gray" squadrons also aided in the creation of the APG-63(V)3 AESA radar, which is now being offered to the USAF and of which the Air Force has already purchased six for installation into C-models in 2006.[3] That figure is unlikely to change dramatically until the Air Force has equipped the F-15E strike fleet with the radar, which offers an air-to-ground performance superior to the E-model's existing strike-optimized APG-63(V)1. The APG-63(V)3 will increase pilot effectiveness through utilization of its beam-steering technology and long-range detection and tracking. Its flexibility and the ability to operate in both search and multi-track track modes simultaneously makes for better SA, and its simultaneous multi-weapon support – a major force multiplier – and superior detection and breakout ranges against targets (including those that are small or stealthy) is a major advantage.



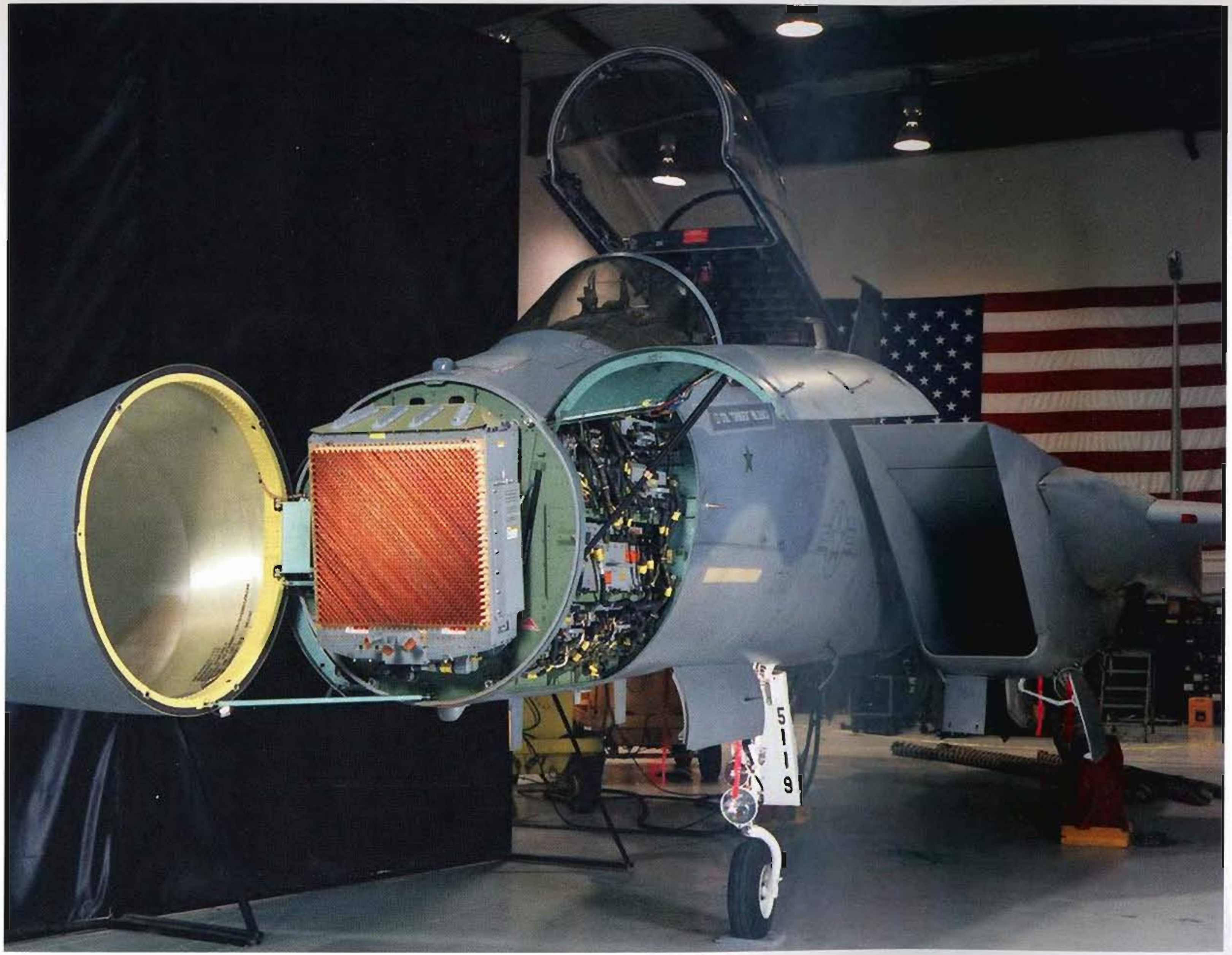
FINALLY, A POUND FOR AIR TO GROUND

Another improvement to the current Eagle is the Embedded GPS/INS (EGI), a satellite navigation system that ties in with the RLG INS in order to provide the Eagle with the most accurate navigation system in its history. The Eagle was the last jet fighter in the USAF's inventory to receive the modification, a fact that reflects the Eagle's pure air-to-air role in US service, and which demonstrates that the RLG INS is sufficiently accurate to allow the Eagle to do its job. Installation of the EGI may be tied to a persistent, if not fully committed interest that the USAF has in taking the Eagle back to its roots and utilising it as a multi-role platform. In 2001 the USAF formally requested that Boeing look into the feasibility of employing the GBU-39 Small Diameter Bomb (SDB) from its Eagle fleet. SDB is a small, 250lb, GPS-guided "smart" bomb with the destructive properties of a 1,000lb bomb. Boeing concluded that the idea was perfectly feasible and would require only small, inexpensive changes to make it a reality.[4] The Air Force dropped the idea, though. More recently, at least one F-15C squadron has spent time employing the

LEFT
This is the "SIT" display for the Fighter Data Link, the system which was developed instead of JTIDS, but offered very similar capabilities. This SIT display shows an eight-ship wall of Eagles about to engage three pairs of MiG-29s over an enemy airfield. (USAF via Steve Davies)

ABOVE
With visiting F-15E Strike Eagles in the background (deployed to Eglin to participate in the air-to-ground WSEP), the 33rd FW "Nomads" flagship (80-0005) blasts off for an ACMI training mission over the Gulf of Mexico. (Tyson V. Rininger: www.tvrphotography.com)

gun against ground targets in the hope that it could bring some small capability to the global war on terror. Again, the Air Force snubbed the idea. However, perhaps the installation of EGI – a prerequisite if the Eagle community is ever forced to strap JDAM and SDB to its jets – signals that the Air Force knows it will one day concede that the Eagle will finally be required to utilize the secondary air-to-ground capability designed into the airframe back in the late 1960s.



OPPOSITE
The mass rollout of the Joint Helmet Mounted Cueing System (JHMCS) to the F-15 community began around 2005. Combined with the high off-boresight AIM-9X, it finally gives the Eagle a response to the previously superior capabilities of the Su-27 and MiG-29 at the merge. (Steve Davies: www.fjphotography.com)

ABOVE
The advent of AESA will take the Eagle to the next stage in capabilities. While the AESA APG-63(V)2 (pictured) has been flown by a single squadron of Eagles, the APG-63(V)3, or more likely (V)4, will be the first AESA radar rolled out to the fleet in large quantities. (Boeing)

ABOVE
Not quite the end of the road… but you can see it from here. Although the number of Eagles in USAF service is gradually decreasing with the changes that BRAC, the F-22A and F-35 bring with them, the Eagle is set to remain a dominant air superiority platform into the 2010s. (Steve Davies: www.fjphotography.com)

With ever-decreasing defense budgets there are fewer and fewer dollars available for the "legacy" F-15, F-16 and F-15E, and the Air Force is ploughing the lion's share of its budget into the F-35, and especially the F-22A Raptor – a jet that can, does and when it goes to war, will, drop JDAM. One gets the impression, too, that the newer Eagle Drivers are chomping at the bit to get a "piece of action" in Iraq and Afghanistan – the quintessential detest for the B-word that so many of the old hands harbor is not necessarily shared by the newer generation of Eagle babies who want to take the fight to the enemy, even if that does mean shunning decades-old traditions and schools of thought.

SHADES OF THE FUTURE: THE "GOLDEN EAGLES"[4]

Modern air forces, and increasingly those with the biggest budgets, are looking to the next generation of jet fighters – the 5th generation – for their future air defense and air superiority needs. The US Air Force is now more than 20 years into the development of the F-22A Raptor, and the first Raptor squadron finally reached IOC in December 2005. The Raptor is designed to replace the F-15 Eagle and, as one would expect, it outperforms the latter in every arena including sensor fusion, avionics capabilities, cockpit design and raw air-to-air performance. Moreover, the Raptor features low-observable characteristics and design features that allow it to operate with relative impunity. However, the USAF has been informed by the Secretary of Defense that it will not be receiving the planned 381 F-22s, but will have to make do with only 183, fewer than half the number required.

This was determined by the Secretary of Defense's 2006 Quadrenniel Defense Review (QDR) which sought to implement the previous year's BRAC requirements while balancing new equipment purchases and force structure changes in a single plan. Because the USAF will not receive its required number of Raptors some 178 Eagles will have to "soldier on" to augment the F-22 beyond 2025, forming a "high/low" mix in capability that is reminiscent of the "high/low" mix (in cost) of the 1970/80s. The Eagles with a future are known as the "Golden Eagles."

The 178 "Golden Eagles" have been specifically selected by tail number, based on their youth, capabilities, current health and maintenance histories. Those 200 airframes not selected will be retired at a rate of about 20 per year through to 2018. The Eagle was originally designed for a life of 4,000 flight hours (see page 19), but McAir engineers did such a great job building a robust airframe that, with minor structural modifications – new ribbing under weapons stations, rebuilding the vertical tails and replacement of some flight control systems – the aircraft will easily surpass 8,000 hours fatigue life. These modifications have almost all been funded and the select 178 "Golden Eagles" will all undergo these structural upgrades at depot in 2008–10.

Additionally, the "Golden Eagles" will receive capability upgrades to bring them all up to the highest standards of the latest MSIP F-15C. These include fitting of APG-63(V)3 AESA radars in the nose, new GPS/INS systems, a new IFF system, JHMCS to better use the AIM-9X, and the fabulous F100-PW-220 engine. Later enhancements forecast include a greatly enhanced CC, upgraded EW suite and improved Link 16 data systems. These upgrades will allow the Eagle to augment the F-22 in combat against the most sophisticated air-to-air threats and IADS defences, enabling it to maintain air dominance in areas of the world that lack these features and thus saving the Raptors for more dangerous missions.

The tight integration of the F-15 with the F-22 has resulted in a major shift in USAF force structuring, so that now two types of same-mission fighters will be based together in spite of the logistic burden of supporting both airframes at a single base. For example, while the 1st FW's 27th and 94th FSs have converted to the F-22, the 71st FS augments them with the 24 AESA radar F-15Cs received from Alaska when the Raptor arrived there.

Many of the 1st FW's Eagles were transferred to Eglin's 33rd FW, and in turn, Eglin's jets were passed to the 65th Aggressor Squadron at Nellis. This dedicated Aggressor unit complements the Viper-equipped 64th Aggressor Squadron, and provides realistic "red air" training by simulating Su-27 "Flankers" to visiting units during the fortnightly Red Flag exercises.

More changes loom on the horizon, the saddest of which is the news that the 33rd FW – the Wing with more MiG kills with the Eagle than any other AF unit – will eventually bid its F-15s farewell as it becomes the F-35 Joint Strike Fighter FTU. When it does, the transition from the world's most successful jet fighter will truly herald the end of a remarkable era for the USAF's leading MiG-killer Eagle Wing.

IOWA

APPENDICES

APPENDIX A
EAGLE OPERATORS

UNITED STATES AIR FORCE

1st Fighter Wing	F-15A/B/C/D	Langley AFB, Virginia
■ 27th FS Fightin' Eagles	Converted to F-22 Raptor effective December 2005	
■ 71st FS Mailed Fist	26 F-15C/D	
■ 94th FS Hat in the Ring	Converted to F-22 Raptor effective June 2006	
3rd Wing (formerly the 21st Combined Wing)	F-15C/D	Elmendorf AFB, Alaska
■ 12th FS Dirty Dozen	Inactivated in August 2007	
■ 19th FS Gamecocks	21 F-15C/D	
■ 43rd FS Polar Bears	Redesignated 19th FS on January 1, 1994	
■ 54th FS Leopards	Redesignated 12th FS on April 28, 2000	
18th Wing	F-15C/D	Kadena AFB, Japan
■ 12th FS Dirty Dozen	Inactivated April 2000, designation moved to 3rd Wing	
■ 44th FS Vampires	24 F-15C/D	
■ 57th FS Fighting Cocks	24 F-15C/D	
32nd Fighter Group	F-15A/B/C/D	Soesterberg AB, Netherlands
■ 32nd FS Wolfhounds	Inactivated January 1994	
33rd Fighter Wing	F-15A/B/C/D	Eglin AFB, Florida
■ 58th FS Gorillas	26 F-15C/D	
■ 59th FS Golden Pride	Inactivated December 1997	
■ 60th FS Fighting Crows	26 F-15C/D	
36th Fighter Wing	F-15A/B/C/D	Bitburg AB, Germany
■ 22nd FS Stingers	Transferred to 52nd FW/converted to F-16 in April 1994	
■ 53rd FS Tigers	Transferred to 52nd FW, Spangdahlem AB, February 1994	
■ 525th FS Bulldogs	Inactivated April 1992	
46th Test Wing	F-15A/B/C/D	Eglin AFB, Florida
■ 40th FLTS Fightin' Red Devils	Tests munitions, ECM and navigation systems for the AFSC Air Armament Center	
48th Fighter Wing	F-15C/D	RAF Lakenheath, England
■ 493rd FS Grim Reapers	18 F-15C/D	
49th Fighter Wing	F-15A/B	Holloman AFB, New Mexico
■ 7th FS Bunyaps	Inactivated September 1992; became F-117 unit September 1993	

OPPOSITE
A 110th FS, 131st FW F-15C tanks mid-session, during an exercise with the Terra Haute, IN, ANG's F-15s. The Eagle's long-look radar led to the F-15 community developing the "exploding cantaloupe" tactic to give them a chance that at least one aircraft might make it to the merge! (Steve Davies: www.fjphotography.com)

■ 8th FS Black Sheep	Converted to F-117 from August 1993–July 1994	
■ 9th FS Iron Knights	Converted to F-117 from August 1993–July 1994	
52nd Fighter Wing	F-15C/D	Spangdahlem AB, Germany
■ 53rd FS Tigers	Inactivated March 1999	
53rd Wing	F-15C/D	Eglin AFB, Florida
■ 85th TES Skulls	Conducts operational tests and evaluations	
■ 422nd TES Green Bats	Evaluates tactics, weapons and modifications prior to introduction into operational service	
57th Wing	F-15C/D	Nellis AFB, Nevada
■ 433rd FWS Satan's Angels	F-15 Fighter Weapons School	
58th/405th Tactical Training Wing	F-15A/B/D	Luke AFB, Arizona
Redesignated 405th TTW in August 1979 so that the 58th TTW could become the F-16 RTU		
■ 426th FS Killer Claws	Activated on January 1, 1981; inactivated November 1990	
■ 461st FS Deadly Jesters	Converted to F-15E August 1987; inactivated August 1994	
■ 550th FS Silver Eagles	Converted to F-15E May 1989; inactivated March 1995	
■ 555th FS Triple Nickel	Inactivated May 1989; designation moved to 31st Wing, Aviano AB, Italy, April 1, 1994 as new title for 526th FS transferred from Ramstein	
325th Fighter Wing	F-15A/B/C/D	Tyndall AFB, Florida
■ 1st FS Griffins	24 F-15C/D	
■ 2nd FS Unicorns	24 F-15C/D	
■ 95th FS Boneheads	24 F-15C/D	
366th Wing	F-15C/D	Mountain Home AFB, Idaho
■ 390th FS Wild Boars	Converted to F-15E in June 2007	
412th Test Wing	F-15A/BC/D	Edwards AFB, California
■ 445th FLTS Fightin' Red Devils	Tests airframe modifications, engines and other components	

Warner Robins Air Logistics Center	Robins AFB, Georgia
■ 2875th FLTS	Two F-15As for pilot proficiency. Mission: perform functional check flights on all F-15s on completion of depot maintenance, overhaul or repair

AEROSPACE DEFENSE COMMAND

5th FIS				
	Spittin' Kittens	F-15A/B	Inactivated July 1, 1988	Minot AFB, North Dakota
48th FIS				
		F-15A/B	Inactivated September 30, 1991	Langley AFB, Virginia
57th FIS				
	Black Knights	F-15C/D	Inactivated March 2, 1995	NAS Keflavik, Iceland
318th FIS				
	Green Dragons	F-15A/B	Inactivated December 7, 1989	McChord AFB, Washington

AIR NATIONAL GUARD

102nd FW Massachusetts ANG		
101st FS	F-15A/B	Otis ANGB, Cape Cod, MA
116th FG Georgia ANG		
128th FS	F-15A/B	Dobbins ANGB, GA (Until August 1995)
125th FW Florida ANG		
159th FS	F-15A/B	Jacksonville International Airport (IAP), FL
131st FW Missouri ANG		
110th FS	F-15A/B	Lambert Field-St Louis IAP, MO
142nd FW Oregon ANG		
123rd FS	F-15A/B	Portland IAP, OR
154th Wing Hawaii ANG		
199th FS	F-15A/B	Hickam AFB, HI
159th FW Louisiana ANG		
122nd FS	F-15A/B	NAS New Orleans, LA
173rd FW Oregon ANG		
114th FS	F-15A/B	Klamath Falls IAP, OR

ROYAL SAUDI AIR FORCE

No. 2 Squadron	F-15C/D	King Faisal AB, Tabuk
No. 5 Squadron	F-15C/D	King Fahad AB, Taif
No. 6 Squadron	F-15C/D	King Khaled AB, Khamis Mushayt
No. 13 Squadron	F-15C/D	King Abdullah Aziz AB, Dhahran
No. 34 Squadron	F-15C/D	King Fahad AB, Taif
No. 42 Squadron	F-15C/D	King Abdullah Aziz AB, Dhahran

HEYL HA'AVIR

8 Bacha (8th Wing)

■ 106 Tayeset	F-15C/D	Tel Nov AB
■ 133 Tayeset	F-15A/B	Tel Nov AB
■ 148 Tayeset*	F-15A/B/D	Tel Nov AB

* (reserve holding squadron for attrition replacement airframes)

NIHON KOKU JIETAI

2nd Koku-dan		
201 Hiko-tai and 203 Hiko-tai	F-15J/DJ	Chitose AB, Hokkaido Island
5th Koku-dan		
23 Hiko-tai	F-15J/DJ	Nytabaru AB, Kyushu Island
6th Koku-dan		
303 Hiko-tai and 306 Hiko-tai	F-15J/DJ	Komatsu AB, Honshu Island
7th Koku-dan		
204 Hiko-tai and 305 Hiko-tai	F-15J/DJ	Hyakuri AB, Honshu Island
8th Koku-dan		
304 Hiko-tai	F-15J/DJ	Tsuiki AB, Kyushu Island
Hiko Kyodo-tai (aggressor unit)	F-15J/DJ	Nyutabaru AB, Kyushu Island

ABOVE
The November 2005 reactivation of the 64th Aggressor Squadron at Nellis AFB saw the application of two-tone brown and blue camouflage schemes for the first time to the "light gray" Eagle fleet. (Rob Tabor)

APPENDIX B

F-15 EAGLE MISHAPS

TABLE 1: UNITED STATES AIR FORCE

Date	S/N	F-15	Squadron/Wing	Cause/Location
10-14-1975	73-0088	A	555 TFTS/58 TFTW	West of Minersville, Utah, due to electrical smoke/fire from generator failure. Pilot ejected safely.
2-28-1977	74-0129	A	433 FWS/57 FWW	Mid-air collision on Nellis AFB ranges, Nevada, with F-5E. Pilot ejected safely.
12-6-1977	75-0085	B	433 FWS/57 FWW	On Nellis AFB ranges, Nevada, during ACM, killing pilot, LtCol David Jacobson, and backseater.
2-8-1978	73-0097	A	555 TFTS/58 TFTW	Destroyed in ground incident.
4-17-1978	75-0059	A	525 TFS/36 TFW	Crashed into North Sea off the coast of Cromer, Norfolk, United Kingdom. Engines flamed out due to fuel starvation during DACT with F-5E aggressors. Pilot ejected safely.
6-15-1978	76-0047	A	53 TFS/36 TFW	Crashed into North Sea following dual engine stall/stagnation. Pilot couldn't restart engines and ejected 124nm from RAF Alconbury.
7-6-1978	76-0053	A	53 TFS/36 TFW	Near Daun, West Germany, during radar trail departure. Pilot spatially disoriented in cloud and was killed in crash.
9-1-1978	75-0018	A	71 TFS/1 TFW	Into the Atlantic Ocean 200nm off Norfolk, Virginia.
12-19-1978	75-0063	A	525 TFS/36 TFW	Near Ahlhorn, West Germany. Uncontrollable engine fire during ACT; pilot ejected safely.
12-28-1978	75-0064	A	22 TFS/36 TFW	Two miles south of Daun, West Germany. One engine shut down due to fire, other engine failed. Pilot ejected safely.
12-29-1978	74-0136	A	433 FWS/57 FWW	On Nellis ranges, Nevada.
2-16-1979	77-0107	A	9 TFS/49 TFW	On Nellis ranges, Nevada.
3-12-1979	77-0076	A	9 TFS/49 TFW	Near El Paso, Texas.
4-25-1979	77-0167	B	McAir	Near Fredericktown, Missouri, on second test flight. Pilot killed.
6-3-1979	76-0035	A	53 TFS/36 TFW	Controls failed on take-off at Bitburg AB, West Germany.
9-13-1979	76-0085	A	57 FWW	On Nellis ranges, Nevada.
10-3-1979	77-0072	A	9 TFS/49 TFW	Mid-air collision near NAS Fallon, Nevada, with F-15A 77-0061 (landed okay).
4-3-1980	75-0070	A	22 TFS/36 TFW	Near Baden-Baden, West Germany.
3-6-1980	76-0082	A	22 TFS/36 TFW	Near Bitburg, West Germany.
3-10-1980	75-0023	A	27 TFS/1 TFW	Burnt out on flight line at Langley AFB, Virginia.
7-25-1980	76-0013	A	525 TFS/36 TFW	29nm NNE of Spangdahlem, West Germany.
1-21-1981	77-0164	B	57 FWW	Mid-air collision on Nellis ranges with F-5E 74-1517. Both F-15 pilots and F-5E pilot killed.
2-17-1981	76-0065	A	555 TFTS/405 TTW	Crashed into Pacific Ocean. Pilot ejected but killed.
6-23-1981	79-0040	C	525 TFS/36 TFW	Near Bremen, West Germany, due to G-LOC during low altitude intercepts.
9-12-1981	80-0007	C	22 TFS/36 TFW	Crashed at the end of F-15 demonstration display, overshot landing at Soesterberg AB, Netherlands.
11-2-1981	75-0051	A	59 TFS/33 TFW	Mid-air collision near Panama City, Florida, with F-15 76-0048 (landed okay) during night refueling. Pilot killed.
12-15-1981	73-0106	A	461 TFTS/58 TFTW	Near Phoenix, Arizona.

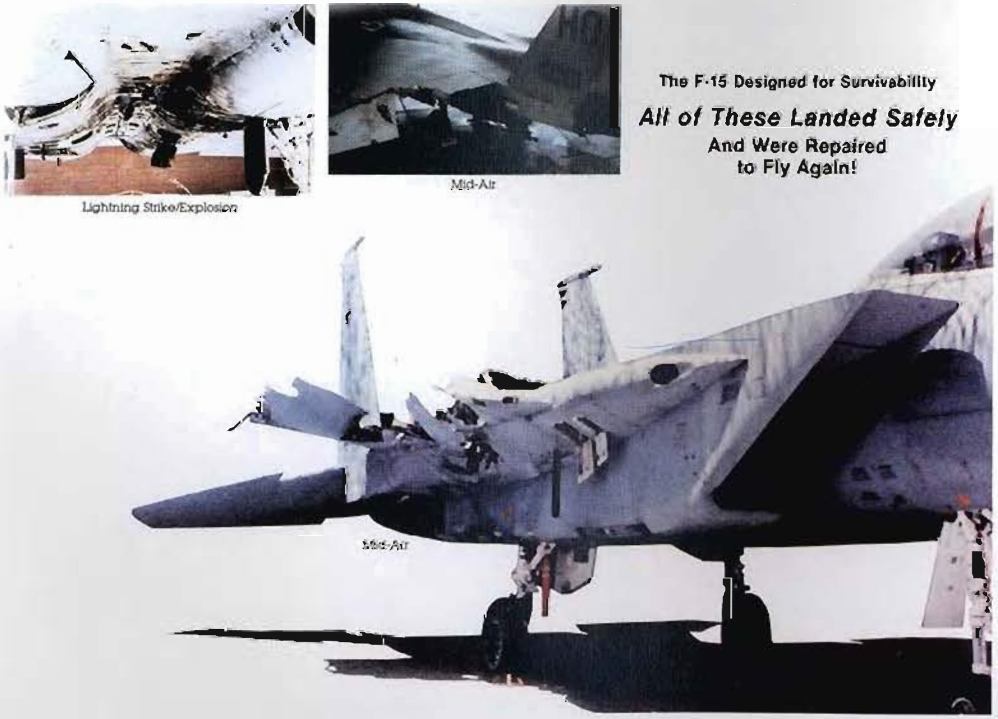
4-6-1982	78-0524	C	12 TFS /18 TFW	Crashed into Pacific Ocean 40 miles NW of Okinawa, Japan, due to massive uncontrollable fuel leak. Pilot ejected safely.
12-22-1982	80-0025	C	53 TFS/36 TFW	Near Herschbach, West Germany, during Zulu Tango scramble. Cabin pressurization and oxygen system failure. Pilot Capt Jeffrey Roether killed.
12-28-1982	78-0481	C	67 TFS/18 TFW	Mid-air collision over Pacific Ocean, 92 miles NE of Okinawa, Japan, with F-15C 78-0540. Pilot ejected safely.
12-28-1982	78-0540	C	67 TFS/18 TFW	Mid-air collision over Pacific Ocean, 92 miles NE of Okinawa, Japan, with F-15C 78-0481. Pilot killed.
1-4-1983	80-0036	C	94 TFS/1 TFW	Unrecoverable spin; crashed into Atlantic Ocean 150nm off North Carolina coast. Pilot ejected safely.
2-4-1983	76-0081	A	59 TFS/33 TFW	Unrecoverable roll ("autoroll"); crashed into Gulf of Mexico near Tyndall AFB. Pilot ejected safely.
5-9-1983	77-0094	A	7 TFS/49 TFW	Pilot lost control during rudder roll; crashed at White Sands Missile Range, New Mexico. Pilot ejected safely.
6-1-1983	79-0071	C	53 TFS/36 TFW	Mid-air collision near Kusel, West Germany, with F-15C 80-0008. Pilot ejected safely.
6-1-1983	80-0008	C	53 TFS/36 TFW	Mid-air collision near Kusel, West Germany, with F-15C 79-0071. Pilot Capt Rich Kendel killed.
6-10-1983	75-0076	A	59 TFS/33 TFW	Mid-air collision 45 miles N of Cold Lake, Canada, with 57th FWW F-5E 74-1509 (pilot killed). F-15 pilot ejected safely.
3-9-1984	74-0094	A	43 TFS/21 TFW	Near Goose Bay, Alaska.
4-10-1984	79-0044	C	525 TFS/36 TFW	Near Lommersdorf, West Germany.
8-17-1984	74-0139	B	43 TFS/21 TFW	Flew into mountain while IMC (instrument meteorological conditions) 87nm NW of Elmendorf AFB, Alaska. Pilot killed.
8-21-1984	75-0087	B	1 TFTS/325 TTW	Mid-air collision over Gulf of Mexico with 526 TFS/86 TFW F-4E 68-0535.
3-20-1985	74-0120	A	43 TFS/21 TFW	Crashed into Yellow Sea, 15 miles NW of Kunsan AB, South Korea. Pilot killed.
6-24-1985	74-0087	A	43 TFS/21 TFW	Crashed into Yukon River, Alaska shortly after take-off. Pilot killed.
9-9-1985	74-0090	A	43 TFS/21 TFW	Crashed near Goose Bay, Alaska.
12-16-1985	84-0042	D	3246 TW	Crashed into Gulf of Mexico, 53 miles SE of Eglin AFB, Florida.
1-2-1986	80-0037	C	57 FIS	Crashed into Atlantic Ocean, 80 miles south of Iceland. Pilot killed.
1-7-1986	79-0061	C	525 TFS/ 36 TFW	Mid-air collision near Rimschweiler, West Germany, with F-15C 80-0032.
1-7-1986	80-0032	C	525 TFS/36 TFW	Mid-air collision near Rimschweiler, West Germany, with F-15C 79-0061.
1-15-1986	76-0023	A	5 FIS	Crashed in the Guadelupe Mountains, near White Sands Missile Range.
3-7-1986	76-0055	A	426 TFTS/ 405 TTW	Mid-air collision with F-15A 76-0074.
3-7-1986	76-0074	A	426 TFTS/405 TTW	Mid-air collision with F-15A 76-0055.
6-9-1986	78-0472	A	67 TFS/18 TFW	Crashed into Pacific Ocean, 118 miles from Kadena AB, Okinawa.
9-12-1986	77-0153	A	9 TFS/49 TFW	Mid-air collision with another F-15A which landed safely.
3-9-1987	77-0075	A	9 TFS/49 TFW	Controls connected incorrectly. Crashed 3 miles SE of Holloman AFB, New Mexico. Pilot killed.
5-19-1987	78-0495	C	44 TFS/18 TFW	Crashed into Pacific Ocean 68 miles from Kadena AB, Okinawa.
6-8-1987	81-0056	C	27 TFS/1 TFW	G-LOC. Crashed near Farmville, Virginia, during low altitude intercepts. Pilot killed.
10-1-1987	75-0027	A	1 TFTS/325 TTW	Crashed in Apalachicola Forest, Florida. Pilot ejected safely.
11-24-1987	75-0056	A	128 TFS/116 TFW	Mid-air collision with F-16B 79-0419, 466 TFS, near Wadley, Georgia. F-16 landed safely. F-15 pilot ejected safely.

11-8-1988	80-0017	C	54 TFS/21 TFW	Crashed 5 miles NW of Kodiak, Alaska.
5-1-1989	76-0138	B	95 TFTS/325 TTW	Crashed into Gulf of Mexico 65 miles SE of Tyndall AFB, Florida. Pilot was killed.
5-18-1989	76-0056	A	2 TFTS/325 TFTW	Crashed near Frink, Florida.
7-8-1989	85-0109	C	58 TFS/33 TFW	Crashed near Lamison, Alabama. Pilot ejected safely.
8-10-1989	77-0101	A	7 TFS/49 TFW	Crashed 60 miles N of Holloman AFB, on White Sands Missile Range, New Mexico.
11-6-1989	84-0029	C	57 FWW	Crashed 60 miles N of Nellis, Nevada. Pilot ejected but was injured.
12-28-1989	86-0153	C	59 TFS/33 TFW	Crashed into Gulf of Mexico, 40 miles SE of Apalachicola, Florida. Pilot killed.
1-16-1990	80-0059	D	21 TFW/3 TFW	Crashed into Big Mount Susitana approximately 30 miles SW of Anchorage, Alaska. Pilot killed.
1-24-1990	78-0534	C	12 TFS/18 TFW	Mid-air collision with F-15C 78-0520 which landed safely and was repaired. Crashed into Chinese Sea 50 miles NW of Clark AFB, Philippines. Pilot killed.
3-15-1990	76-0069	A	426 TFTS/405 TTW	Lost control during ACM. Crashed 70 miles N of Phoenix, Arizona. Pilot ejected safely.
4-25-1990	81-0049	C	32 TFS	Crashed 9 miles off the coast of England into sea. Pilot ejected safely.
10-24-1990	79-0067	C	22 TFS/36 TFW	Crashed into Mediterranean 30 miles from Decimomanu, Italy. Pilot ejected safely and was rescued.
3-27-1991	78-0526	C	12 TFS/18 TFW	Crashed 2 miles W of Osan AB, South Korea. Pilot ejected safely.
1-15-1992	75-0071	A	128 TFS/116 TFW	Mid-air collision with F-15C 75-0075 (landed safely, repaired and returned to flight). Pilot ejected safely.
1-21-1992	81-0052	C	57 FWW	Crashed in Nellis ranges, 75 miles north of Las Vegas. Pilot ejected safely.
4-22-1992	80-0023	C	22 TFS/36 TFW	Crashed near Stuttgart, Baden-Wurtemberg, Germany, during ACM with Canadian Armed Forces CF-188s. Pilot killed.
7-13-1992	85-0116	C	60 FS/33 FW	Crashed into Gulf of Mexico 90 miles S of Eglin AFB, Florida.
12-1-1992	83-0021	C	71 FS/1 FW	Crashed into Arabian Gulf 80 miles SSE of Dhahran, Saudi Arabia. Pilot ejected safely.
3-15-1993	79-0027	C	95 FS/325 FW	Crashed into Gulf of Mexico, 100 miles S of Tyndall AFB. Pilot ejected safely.
6-12-1993	77-0117	A	122 FS/159 FW	Crashed 30 miles E of NAS New Orleans, Louisiana. Pilot ejected safely.
12-17-1993	75-0054	A	122 FS/159 FW	Mid-air collision over Atlantic Ocean off Brunswick, Georgia, with F-16A 82-0927, 184 FS, Arkansas ANG (crashed killing pilot). F-15 pilot ejected safely.
4-4-1994	78-0497	C	44 FS/18 FW	Crashed shortly after take-off from Kadena AB, Okinawa, Japan. Pilot ejected safely.
5-5-1994	79-0058	C	1 FS/325 FW	G-LOC. Pilot recovered and ejected at 1.14 Mach. He was seriously injured but was rescued.
5-6-1994	78-0530	C	67 FS/18 FW	Mid-air collision 2 miles off the coast of South Korea with F-16C 87-0274, 80 FS (also crashed). One pilot killed.
5-30-1995	79-0068	C	53 FS/52 FW	Controls connected incorrectly. Crashed during take-off at Spangdahlem AB, West Germany. Pilot fatally injured and died en route to hospital.
8-3-1995	78-0537	C	67 FS/18 FW	Crashed 100 miles E of Elmendorf AFB in Yukon-Charley Rivers National Preserve, Alaska, during Cope Thunder. Pilot ejected safely and was rescued.
10-18-1995	78-0529	C	44 FS/18 FW	Crashed into Pacific Ocean 65 miles S of Kadena AB. Pilot ejected safely and was rescued.
11-9-1995	76-0061	A	110 FS/131 FW	Engine fire. Pilot over controlled and landed 100 knots too fast at Whiteman AFB, Missouri, and ran off the runway.
3-21-1996	82-0023	C	27 FS/1 FW	Crashed during take-off from Nellis AFB, Nevada. Pilot ejected and sustained minor injuries.
8-27-1996	86-0150	C	390 FS/336 AEW	Crashed during a routine mission from Mountain Home AFB, Idaho. Pilot ejected safely.

1-10-1997	85-0099	C	58 FS/33 FW	Caught fire on take-off from Eglin AFB, Florida. Pilot returned for an immediate landing and egressed safely on the ground. Aircraft completely destroyed by fire.
11-24-1997	83-0033	C	94 FS/1 FW	Crashed 60 miles off the coast of Virginia. Pilot ejected safely and was rescued.
6-5-1998	77-0120	A	122 FS/159 FW	Problems during take-off at NAS New Orleans. Pilot ejected and aircraft crashed at end of runway.
1-28-1999	82-0020	C	85 TES/53 WG	Mid-air collision over Gulf of Mexico 80 miles S of Eglin AFB, Florida, with F-15C 84-0011. Pilot ejected with minor injuries and was rescued.
1-28-1999	84-0011	C	85 TES/53 WG	Mid-air collision over Gulf of Mexico 80 miles S of Eglin AFB, Florida, with F-15C 82-0020. Pilot ejected and was rescued.
6-15-1999	82-0008	C	422 TES/57 FWW	Mid-air collision over Nellis Ranges 60 miles E of Tonopah, Nevada, with F-15C 79-0013. Pilot ejected safely.
6-15-1999	79-0013	D	445 FLTS/412 TW	Mid-air collision over Nellis Ranges 60 miles E of Tonopah, Nevada, with F-15C 82-0008. Pilot ejected safely.
8-19-1999	76-0117	A	110 FS/131 FW	Mid-air collision near Lindberg, Missouri, with F-15A 77-0118 (landed safely). Pilot ejected safely.
8-3-2000	86-0173	C	493 FS/48 FW	Crashed on the Nellis ranges near Rachel, Nevada. Pilot ejected safely.
3-26-2001	86-0169	C	493 FS/48 FW	Crashed into hills in Scotland during IMC conditions. Pilot was killed.
3-26-2001	86-0180	C	493 FS/48 FW	In formation with 86-0169. Crashed into hills in Scotland during IMC conditions. Pilot was killed.
4-30-2002	80-0022	C	46th Test Wing	Unknown.
8-21-2002	78-0541	C	18th Wing	Unknown.
3-17-2003	80-0030	C	53rd Wing	Unknown.
5-21-2004	81-0027	C	325th Fighter Wing	Crashed into Gulf of Mexico following inadvertent ejection during defensive BFM. The pilot's CRU-94 came loose from harness and lodged in ejection handle during BFM maneuvering; when the pilot turned his head to look behind the aircraft the CRU-94 pulled the ejection handle. Pilot survived.
6-18-2004	79-0054	C	57th Wing	A loss of fuel to both engines resulted in a dual-engine flameout and subsequent ejection 60 miles north of Nellis Air Force Base, Nevada. The loss of fuel was most likely caused by the left and right fire warning light buttons being inadvertently activated, cutting off fuel flow and making it impossible to restart either engine.
3-25-2005	80-0052	C	53rd Wing	Unknown.
5-30-2007	(believed to be) AF78-0571	D	110th FS, 131st FW	Crashed in southern Indiana during a 4 vs. 4 of MOGAR Eagles and Terre Haute F-16s. Pilot ejected safely. Incident occurred two days before going to press, and no further details were available.

TABLE 2: ISRAELI AIR FORCE

Date	S/N	F-15	Squadron	Cause
8-1979	Unknown	A	133 *Tayeset*	Crashed after dual engine flameout due to ingestion of storks.
9-29-1979	676	A	133 *Tayeset*	Crashed on approach for night landing in bad weather. Pilot killed.
4-1-1987	223	D	106 *Tayeset*	Crashed following a spin. Although the rear seat occupant survived ejection, the pilot did not.
8-15-1988	672	A	133 *Tayeset*	Crashed near the Dead Sea after colliding with F-15A 684. Aircraft named Tornado and was credited with one kill. Pilot was reportedly killed during ejection.
8-15-1988	684	A	133 *Tayeset*	Crashed near the Dead Sea, after colliding with F-15A 672. Pilot was killed.
2-10-1991	821	C	106 *Tayeset*	Cause of accident unknown. Pilot ejected but drowned.
8-10-1995	965	D	106 *Tayeset*	Bird strikes resulted in fire and structural damage, causing subsequent inflight break-up. Both pilots ejected but were killed.
1-13-1997	137	B	106 *Tayeset*	Bird strikes resulted in spin. Crashed in Negrev Desert. Aircraft named Rats Hamelech (The King's Messenger). Both pilots ejected safely.
3-1-1998	142	B	106 *Tayeset*	Hit antenna mast during low-level flying. Both pilots were killed.


Lightning Strike/Explosion
Mid-Air
The F-15 Designed for Survivability
All of These Landed Safely
And Were Repaired to Fly Again!
Mid-Air

LEFT
The F-15 was designed to be as survivable as possible, but when the IAF told McAir that it had landed an Eagle with one wing torn off through a midair collision, even they did not believe it until photographic proof was provided. (Boeing)

TABLE 3: ROYAL SAUDI AIR FORCE

Date	S/N	F-15	Squadron	Cause
5-1982	1308	C	12 Sqn	Unknown.
9-1-1986	610	C	6 Sqn	Crashed near Khamis Mushayt, Saudi Arabia, after colliding with F-15C No. 611, 6 Sqn, RSAF, and although landed thought to be written off.
9-1-1986	611	C	6 Sqn	Crashed near Khamis Mushayt, Saudi Arabia, after colliding with F-15C No. 610, 6 Sqn, RSAF, and although landed thought to be written off.
8-30-1988	511	C	5 Sqn	Crashed near Al Hesa, Saudi Arabia.
7-3-1996	Unkn	C	Unit Unkn	Crashed after a mid-air collision with another RSAF F-15C in the eastern part of Saudi Arabia. Pilot was killed.
7-3-1996	Unkn	C	Unit Unkn	Crashed after a mid-air collision with another RSAF F-15C in the eastern part of Saudi Arabia. Pilot was killed.
2-15-2000	Unkn	C	Unit Unkn	Crashed 150 miles E of Riyadh during night mission. Pilot was killed.

TABLE 4: JAPAN AIR SELF DEFENSE FORCE

Date	S/N	F-15	Squadron	Cause
10-20-1983	12-8053	DJ	202 *Hiko-tai*	Crashed into Pacific Ocean 110 miles E of Nyutabaru AB, Japan, during low altitude night flying training.
3-13-1987	42-8840	J	204 *Hiko-tai*	Crashed into sea 100 miles E of Hyakuri AB, Japan, following suspected spatial disorientation. Pilot killed.
6-29-1988	22-8804	J	303 *Hiko-tai*	Crashed into Sea of Japan, after collision with F-15J 22-8808. Pilot killed.
6-29-1988	22-8808	J	303 *Hiko-tai*	Crashed into Sea of Japan, after collision with F-15J 22-8804. Pilot killed.
7-2-1990	52-8857	J	204 *Hiko tai*	Practicing 2 v 2 radar intercept combat training above Kashimanada Sea when, 43 miles east of Hyakuri AB, and while descending from 10,000 feet to 5,000 feet, disappeared from radar and crashed. Pilot killed.
12-13-1991	12-8079	DJ	201 *Hiko-tai*	Crashed during the approach to Komatsu AB, Japan, following an uncontained engine failure at the rear of the aircraft. Pilot ejected at 1,970ft and sustained injuries.
10-27-1992	72-8884	J	204 *Hiko-tai*	Crashed 45 miles NE of Tokyo, Japan into Pacific Ocean after the pilot reported the aircraft uncontrollable. Pilot ejected but later died.
10-6-1993	82-8064	DJ	202 *Hiko-tai*	Crashed into sea off the coast of northern Japan following fuel problem that the crew investigated for 20 minutes but could not resolve.
10-6-1995	72-8891	J	303 *Hiko-tai*	Reportedly burnt out after a failed take-off of Komatsu AB, Japan.
11-22-1995	02-8919	J	308 *Hiko-tai*	Shot down by an AIM-9L Sidewinder fired by another JASDF F-15. Pilot ejected and was rescued.

APPENDIX C

F-15 EAGLE KILLS

UNITED STATES AIR FORCE

Date	S/N	Pilot	Squadron/Wing	Missile	Kill
1-17-1991	85-0125	Capt John Kelk	58th TFS	AIM-7M	MiG-29
1-17-1991	85-0105	Capt Robert E. Graeter	58th TFS	AIM-7M	2 x Mirage F1EQ
1-17-1991	85-0119	Capt Rhory Draeger (59th TFS)	58th TFS	AIM-7M	MiG-29
1-17-1991	85-0107	Capt Charles Magill (USMC)[2]	58th TFS	AIM-7M	MiG-29
1-17-1991	83-0017	Capt Steve Tate	71st TFS	AIM-7M	Mirage F1EQ
1-19-1991	85-0099	Capt Larry Pitts	58th TFS	AIM-7M	MiG-25
1-19-1991	85-0101	Capt Richard C. Tollini	58th TFS	AIM-7M	MiG-25
1-19-1991	85-0122	Capt Craig Underhill	58th TFS	AIM-7M	MiG-29
1-19-1991	85-0114	Capt Cesar A. Rodriguez, Jr	58th TFS	Ground	MiG-29
1-19-1991	79-0021	Lt David G. Sveden	525th TFS	AIM-7M	Mirage F1EQ
1-19-1991	79-0069	Capt David S. Prather	525th TFS	AIM-7M	Mirage F1EQ
1-26-1991	85-0104	Capt Anthony Schiavi	58th TFS	AIM-7M	MiG-23
1-26-1991	85-0108	Capt Rhory Draeger (59th TFS)	58th TFS	AIM-7M	MiG-23
1-26-1991	85-0114	Capt Cesar A. Rodriguez, Jr	58th TFS	AIM-7M	MiG-23
1-27-1991	84-0025	Capt J. T. Denney	53rd TFS	AIM-9M	2 x MiG-23
1-27-1991	84-0027	Capt Benjamin D. Powell	53rd TFS	AIM-7M	MiG-23 and Mirage F1EQ
1-28-1991	79-0022	Capt Donald S. Watrous	32nd TFS	AIM-7M	MiG-23
1-29-1991	85-0102	Capt David Rose (60th TFS)	58th TFS	AIM-7M	MiG-23
2-2-1991	79-0064	Capt Gregory Masters	525th TFS	AIM-7M	Il-76
2-6-1991	79-0078	Capt Thomas N. Dietz	53rd TFS	AIM-9M	2 x MiG-21
2-6-1991	84-0019	Lt Robert W. Hehemann	53rd TFS	AIM-9M	2 x Su-25
2-7-1991	85-0102	Capt Anthony R. Murphy	58th TFS	AIM-7M	2 x Su-22
2-7-1991	84-0124	Col Rick Parsons	58th TFS	AIM-7M	Su-7
2-7-1991	80-0003	Maj Randy May	525th TFS	AIM-7M	Mi-24
2-11-1991	79-0048	Capt Mark McKenzie	525th TFS	AIM-7M	0.5 Mi-8[3]
2-11-1991	80-0012	Capt Steven Dingee	525th TFS	AIM-7M	0.5 Mi-8
3-20-1991	84-0014	Capt John Doneski	53rd TFS	AIM-7M	Su-22
3-22-1991	84-0010	Capt Thomas N. Dietz	53rd TFS	AIM-9M	Su-22
3-22-1991	84-0015	Lt Robert W. Hehemann	53rd TFS	Ground	PC-9
3-24-1999	86-0169[4]	LtCol Cesar A. Rodriguez, Jr	493rd FS	AIM-120	MiG-29
3-24-1999	86-0159	Capt Mike Shower	493rd FS	AIM-120	MiG-29
3-26-1999	86-0156	Capt Jeff Hwang	493rd FS	AIM-120	2 x MiG 29

ROYAL SAUDI AIR FORCE

Date	S/N	Pilot	Squadron/Wing	Missile	Kill
6-5-1984	Unkn			AIM-7	Imperial Iranian Air Force F-4E
1-24-1991	80-0068	Saleh Al-Shamrani	13 Sqn	AIM-9M	2 x IRAF Mirage F1EQ

ABOVE
"Coma" Powell killed a MiG-23 and a Mirage F1EQ in F-15C 84-027 on January 27, 1991, while "Gigs" Hehemann, flying F-15C 84-015, scared a PC-9 pilot into ejecting. Here the two jets bask in the afternoon sun at RAF Lakenheath, in 2004. (Steve Davies: www.fjphotography.com)

ISRAELI AIR FORCE‘

Date	F15	S/N	Pilot	Missile	Kill
6-27-1979	A	663	Moshe Melnik	Python 3	MiG-21
6-27-1979	A	689	Eitan Ben-Eliyahu	M61A1	MiG-21
6-27-1979	B	704	Joel Feldsho	AIM-7F	MiG-21
6-27-1979	A	672	Yoram Peled	AIM-9G	MiG-21
9-24-1979	A	695	Avner Naveh	Python 3	MiG-21
				M61A1	MiG-21
9-24-1979	A	676	Dedi Rozental	AIM-7F	MiG-21
9-24-1979	A	692	Relik Shafir	AIM-9G	MiG-21
8-24-1980	A	696	Ilan Margalit	AIM-7F	MiG-21
12-31-1980	A	646	Yair Rachmilevitz	AIM-9G	MiG-21
12-31-1980	A	695	Yoav Stern	Python 3	0.5 MiG-21 (shared claim with F-4E)
2-3-1981	A	672	Benyamin Zinker	AIM-7F	MiG-25
7-29-1981	A	673	Sha'ul Simon	AIM-7F	MiG-25
6-7-1982	A	658	Offer Lapidot	Python 3	MiG-23
6-8-1982	A	686	Yoram Hofman	AIM-7F	MiG-21
6-8-1982	D	957	Sha'ul Schwartz/ Reuven Solan	AIM-7F	MiG-21
6-8-1982	C	818	Sha'ul Simon	AIM-7F	0.5 MiG-23
6-8-1982	C	832	Dedi Rozental	AIM-7F	0.5 MiG-23
6-9-1982	A	684	Yoram Peled	Python 3	MiG-21
6-9-1982	A	658	Gil Rapaport	AIM-7F	MiG-23
6-9-1982	C	646	Avi Maor	Python 3	MiG-23
				M61A1	MiG-21
6-9-1982	A	684	Ronen Shapira	AIM-7F	MiG-23
	A	686	Ronen Shapira	Python 3	MiG-21
6-9-1982	C	802	Moshe Melnik	AIM-7F	MiG-21
				Python 3	MiG-23
6-9-1982	A	695	Oran Hampel	AIM-7F	MiG-21
6-10-1982	D	957	Avner Nave/ Michael Cohen	AIM-7F	MiG-23
				Python 3	MiG-23
				Python 3	MiG-21
6-10-1982	C	840	Benyamin Zinker	Python 3	MiG-23
6-10-1982	C	848	Ziv Nadivi	Python 3	SA342L
6-10-1982	C	828	Gil Rapaport	Python 3	MiG-23
6-10-1982	C	802	No'am Knaani	Python 3	2 x MiG-23
6-10-1982	B	708	Sha'ul Schwartz/ Uzi Shapira	Python 3	MiG-21
6-10-1982	C	848	Yoram Hofman	M61A1	MiG-21
6-10-1982	D	955	Miki Lev	Python 3	MiG-21
6-10-1982	A	667	Yiftach Shadmi	Python 3	MiG-21
6-10-1982	C	979	Yoram Peled/ Zvi Lipsitz	Python 3	MiG-21
6-11-1982	A	678	Yoram Peled	AIM-7F	2 x MiG-23
6-11-1982	A	646	Offer Lapidot	Python 3	MiG-21
6-11-1982	C	840	Yiftach Shadmi	Python 3	MiG-21
6-11-1982	B	704	Sha'ul Simon/ Amir Hodorov	Python 3	MiG-21
6-24-1982	D	979	Joel Feldsho/ Zvi Lipsitz	Python 3	2 x MiG-23
8-31-1982	C	821	Sha'ul Schwarz	0.5 MiG-25 (shared with Hawk SAM)	
11-20-1985	C	840	Avner Naveh	Python 3	MiG-23
				Python 3	0.5 MiG-23
11-20-1985	D	957	Yuval Ben-Zur/ Ofer Patz	Python 3	0.5 MiG-23

APPENDIX D

F-15 EAGLE PRODUCTION AND VARIANTS

McDonnell Douglas Aircraft Corporation (McAir) – now Boeing

Version	Quantity	Assembly Location	Time Period
F-15A	384	St. Louis, MO	1972–1979
F-15B	61	St. Louis, MO	1972–1979
F-15C	483	St. Louis, MO	1979–1985
F-15D	92	St. Louis, MO	1979–1985
F-15J	2	St. Louis, MO	1979–1980
F-15DJ	12	St. Louis, MO	1979–1981
Total:	**1,034**		

Mitsubishi Heavy Industries Ltd

Version	Quantity	Assembly Location	Time Period
F-15J/DJ	139/25	Tokyo	1981–1997
Total:	**164**		

Total Produced: 1,198

F-15A

71-0280/0281	McDonnell Douglas F-15A-1-MC Eagle
	-0281 bailed to NASA in 1975. Returned to USAF in 1983, on display at Langley AFB
71-0282/0284	McDonnell Douglas F-15A-2-MC Eagle
	-0284 to GF-15A
71-0285/0286	McDonnell Douglas F-15A-3-MC Eagle
	-0286 to GF-15A
71-0287/0289	McDonnell Douglas F-15A-4-MC Eagle
	0287 bailed to NASA in 1976 as 835
72-0113/0116	McDonnell Douglas F-15A-5-MC Eagle
	-0114, -0116 delivered to Israel, *Peace Fox I*
72-0117/0120	McDonnell Douglas F-15A-6-MC Eagle
	-0117, -0118 delivered to Israel, *Peace Fox I*
	-0119 set eight world time-to-height records as part of Operation *Streak Eagle*
	-0120 delivered to Israel in 1982
73-0085/0089	McDonnell Douglas F-15A-7-MC Eagle
73-0090/0097	McDonnell Douglas F-15A-8-MC Eagle
73-0098/0107	McDonnell Douglas F-15A-9-MC Eagle
74-0081/0093	McDonnell Douglas F-15A-10-MC Eagle
74-0094/0111	McDonnell Douglas F-15A-11-MC Eagle
74-0112/0136	McDonnell Douglas F-15A-12-MC Eagle
74-0143/0157	McDonnell Douglas F-15A/B Eagle – canceled contract
75-0018/0048	McDonnell Douglas F-15A-13-MC Eagle
75-0049/0079	McDonnell Douglas F-15A-14-MC Eagle
75-0090/0124	McDonnell Douglas F-15A/B Eagle – canceled contract
76-0008/0046	McDonnell Douglas F-15A-15-MC Eagle
76-0047/0083	McDonnell Douglas F-15A-16-MC Eagle
76-0084/0113	McDonnell Douglas F-15A-17-MC Eagle
	-0086 used for trials with Vought ASM-135A ASAT.
76-0114/0120	McDonnell Douglas F-15A-18-MC Eagle
76-0121/0123	McDonnell Douglas F-15A Eagle – canceled contract
76-1505/1514	McDonnell Douglas F-15A-17-MC Eagle – for Israel, *Peace Fox II*
76-1515/1523	McDonnell Douglas F-15A-18-MC Eagle – for Israel, *Peace Fox II*
77-0061/0084	McDonnell Douglas F-15A-18-MC Eagle
	-0084 used as test bed for APG-63 radar
77-0085/0119	McDonnell Douglas F-15A-19-MC Eagle
77-0120/0153	McDonnell Douglas F-15A-20-MC Eagle

F-15B

71-290	McDonnell Douglas F-15B-3-MC Eagle – later modified as part of STOL and Maneuver Technology Demonstrator Program (Agile Eagle)
71-291	McDonnell Douglas F-15B-4-MC Eagle – used for evaluation of FAST Pack conformal fuel tanks and LANTIRN pod. Also became development aircraft for F-15E Strike Eagle
73-0108/0110	McDonnell Douglas F-15B-7-MC Eagle
73-0111/0112	McDonnell Douglas F-15B-8-MC Eagle
73-0113/0114	McDonnell Douglas F-15B-9-MC Eagle
74-0137/0138	McDonnell Douglas F-15B-10-MC Eagle
74-0139/0140	McDonnell Douglas F-15B-11-MC Eagle
74-0141/0142	McDonnell Douglas F-15B-12-MC Eagle
74-0143/0157	McDonnell Douglas F-15A/B Eagle – canceled contract
75-0080/0084	McDonnell Douglas F-15B-13-MC Eagle
75-0085/0089	McDonnell Douglas F-15B-14-MC Eagle
75-0090/0124	McDonnell Douglas F-15A/B Eagle – canceled contract
76-0124/0129	McDonnell Douglas F-15B-15-MC Eagle
76-0130/0135	McDonnell Douglas F-15B-16-MC Eagle
76-0136/0140	McDonnell Douglas F-15B-17-MC Eagle
76-0141/0142	McDonnell Douglas F-15B-18-MC Eagle
76-1524/1525	McDonnell Douglas F-15B-16-MC Eagle – For Israel, *Peace Fox II*
77-0154/0156	McDonnell Douglas F-15B-18-MC Eagle
77-0157/0162	McDonnell Douglas F-15B-19-MC Eagle
77-0163/0168	McDonnell Douglas F-15B-20-MC Eagle -- -0166 used as test vehicle for Integrated Flight Control/Firefly III program

ABOVE
Col Doug Dildy approaches a tanker high over the mountains of Turkey in his personal F-15A (77-0100) prior to an Operation *Northern Watch* sortie into Iraq's northern No-Fly Zone. At the time Dildy was the squadron commander of the 32nd FS. (Doug Dildy)

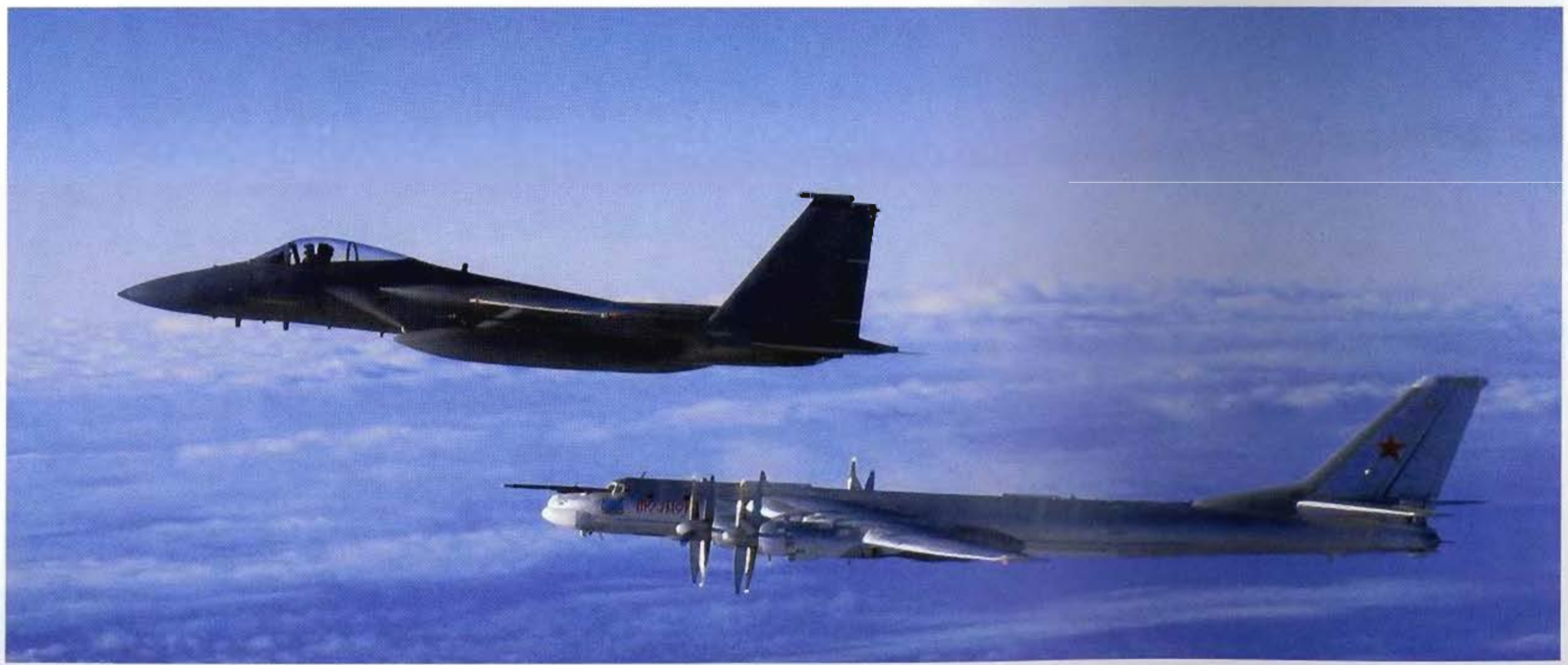
F-15C

78-0468/0495	McDonnell Douglas F-15C-21-MC Eagle
78-0496/0522	McDonnell Douglas F-15C-22-MC Eagle
78-0523/0550	McDonnell Douglas F-15C-23-MC Eagle
78-0551/0560	McDonnell Douglas F-15C Eagle – canceled contract
79-0015/0037	McDonnell Douglas F-15C-24-MC Eagle – -0015, -0017/0019, -0023, -0024, -0028, -0031/0033 transferred to Saudi Arabia
79-0038/0058	McDonnell Douglas F-15C-25-MC Eagle – -0038, -0039, -0043, -0045, -0051, -0052, -0055 transferred to Saudi Arabia
79-0059/0081	McDonnell Douglas F-15C-26-MC Eagle – -0060, -0062, -0063 transferred to Saudi Arabia
80-0002/0023	McDonnell Douglas F-15C-27-MC Eagle
80-0024/0038	McDonnell Douglas F-15C-28-MC Eagle
80-0039/0053	McDonnell Douglas F-15C-29-MC Eagle
80-0062/0067	McDonnell Douglas F-15C-28-MC Eagle – for Saudi Arabia, *Peace Sun*
80-0068/0074	McDonnell Douglas F-15C-29-MC Eagle – for Saudi Arabia, *Peace Sun*
80-0075/0085	McDonnell Douglas F-15C-30-MC Eagle – for Saudi Arabia, *Peace Sun*
80-0086/0099	McDonnell Douglas F-15C-31-MC Eagle – for Saudi Arabia, *Peace Sun*
80-0100/0106	McDonnell Douglas F-15C-32-MC Eagle – for Saudi Arabia, *Peace Sun*
80-0122/0124	McDonnell Douglas F-15C-27-MC Eagle – for Israel, *Peace Fox III*
80-0125/0127	McDonnell Douglas F-15C-28-MC Eagle – for Israel, *Peace Fox III*
80-0128/0130	McDonnell Douglas F-15C-29-MC Eagle – for Israel, *Peace Fox III*
81-0002	McDonnell Douglas F-15C-32-MC Eagle – for RSAF
81-0020/0031	McDonnell Douglas F-15C-30-MC Eagle
81-0032/0040	McDonnell Douglas F-15C-31-MC Eagle
81-0041/0056	McDonnell Douglas F-15C-32-MC Eagle
81-0057/0060	McDonnell Douglas F-15C – canceled contract
82-0008/0022	McDonnell Douglas F-15C-33-MC Eagle
82-0023/0038	McDonnell Douglas F-15C-34-MC Eagle
83-0010/0034	McDonnell Douglas F-15C-35-MC Eagle
83-0035/0043	McDonnell Douglas F-15C-36-MC Eagle
83-0044/0045	McDonnell Douglas F-15C Eagle – canceled contract
83-0054/0055	McDonnell Douglas F-15C-35-MC Eagle – for Israel, *Peace Fox III*
83-0056/0062	McDonnell Douglas F-15C-36-MC Eagle – for Israel, *Peace Fox III*
84-0001/0015	McDonnell Douglas F-15C-37-MC Eagle
84-0016/0031	McDonnell Douglas F-15C-38-MC Eagle
84-0032/0041	McDonnell Douglas F-15C Eagle – canceled contract
85-0093/0107	McDonnell Douglas F-15C-39-MC Eagle – -0102 credited with three kills in Gulf War
85-0108/0128	McDonnell Douglas F-15C-40-MC Eagle

85-0132/0134	McDonnell Douglas F-15C-40-MC Eagle
86-0143/0162	McDonnell Douglas F-15C-41-MC Eagle
86-0163/0180	McDonnell Douglas F-15C-42-MC Eagle
90-263/268	McDonnell Douglas F-15C-49-MC Eagle – for Saudi Arabia, *Peace Sun*
90-269/271	McDonnell Douglas F-15C-50-MC Eagle – for Saudi Arabia, *Peace Sun*

F-15D

78-0561/0565	McDonnell Douglas F-15D-21-MC Eagle
78-0566/0570	McDonnell Douglas F-15D-22-MC Eagle
78-0571/0574	McDonnell Douglas F-15D-23-MC Eagle
78-0575	McDonnell Douglas F-15D Eagle – canceled contract
79-0004/0006	McDonnell Douglas F-15D-24-MC Eagle – all transferred to Saudi Arabia
79-0007/0011	McDonnell Douglas F-15D-25-MC Eagle
79-0012/0014	McDonnell Douglas F-15D-26-MC Eagle
80-0054/0055	McDonnell Douglas F-15D-27-MC Eagle
80-0056/0057	McDonnell Douglas F-15D-28-MC Eagle
80-0058/0061	McDonnell Douglas F-15D-29-MC Eagle
80-0107/0110	McDonnell Douglas F-15D-27-MC Eagle – for Saudi Arabia, *Peace Sun*
80-0111/0112	McDonnell Douglas F-15D-28-MC Eagle – for Saudi Arabia, *Peace Sun*
80-0113/0114	McDonnell Douglas F-15D-29-MC Eagle – for Saudi Arabia, *Peace Sun*
80-0115/0117	McDonnell Douglas F-15D-30-MC Eagle – for Saudi Arabia, *Peace Sun*
80-0118/0119	McDonnell Douglas F-15D-31-MC Eagle – for Saudi Arabia, *Peace Sun*
80-0120/0121	McDonnell Douglas F-15D-32-MC Eagle – for Saudi Arabia, *Peace Sun*
80-0131/0132	McDonnell Douglas F-15D-27-MC Eagle – for Israel, *Peace Fox III*
80-0133/0136	McDonnell Douglas F-15D-28-MC Eagle – for Israel, *Peace Fox III*
81-0003	McDonnell Douglas F-15D-32-MC Eagle – For Saudi Arabia
81-0061/0062	McDonnell Douglas F-15D-30-MC Eagle
81-0063/0065	McDonnell Douglas F-15D-31-MC Eagle
81-0066/0067	McDonnell Douglas F-15D Eagle – canceled contract
82-0044/0045	McDonnell Douglas F-15D-33-MC Eagle
82-0046/0048	McDonnell Douglas F-15D-34-MC Eagle
83-0046/0048	McDonnell Douglas F-15D-35-MC Eagle
83-0049/0050	McDonnell Douglas F-15D-36-MC Eagle
83-0063/0064	McDonnell Douglas F-15D-35-MC Eagle – for Israel, *Peace Fox III*
84-0042/0044	McDonnell Douglas F-15D-37-MC Eagle
84-0045/0046	McDonnell Douglas F-15D-38-MC Eagle
84-0047/0048	McDonnell Douglas F-15D Eagle – canceled contract
85-0139/0131	McDonnell Douglas F-15D-39-MC Eagle
86-0181/0182	McDonnell Douglas F-15D-41-MC Eagle



BELOW
F-15C 85-119 – the same jet in which "Hoser" Draeger scored his MiG-29 kill on January 17, 1991 – intercepts a "Bear" off the Alaskan coast. This jet was the first F-15C to receive the APG-63(V)2 AESA radar, and was assigned to the 12th FS, 3rd W, Elmendorf AFB, Alaska. (USAF)

APPENDIX E
MCDONNELL DOUGLAS F-15 EAGLE TIME LINE

1965 April 29: Headquarters Air Force initiated the F-X program by directing Air Force Systems Command (AFSC) "to begin efforts toward acquiring a new tactical fighter, the F-X."

October 6: The Air Force issued Qualitative Operational Requirement (QOR) 65-14F, which defined what later became known as the F-X (Fighter-Experimental) project

December 8: A Request For Proposals (RFP) was issued for the F-X. The Air Force initially wanted the F-X to be a close-air-support, multi-role aircraft powered by two turbofan jet engines and equipped with variable-geometry wings. Boeing, Lockheed, North American, Grumman, and McDonnell all go to work on initial concept studies.

1966 January: The Air Force received proposals for the F-X from eight companies.

March: The Air Force selected three companies to compete for the F-X contract: Lockheed California Company; North American Aviation, Incorporated; and the McDonnell Aircraft Company.

April: The Air Force issued Concept Formulation Study (CFS) contracts for the F-X to Boeing, Lockheed, and North American. McDonnell Aircraft continued to fund its own studies on the FX.

August: ASD officially established an SPO for the F-X.

1967 June: F-15 Concept Formulation Package.

August 12 The Air Force issued a new RFP for the F-X. The emphasis was now on an air superiority fighter, rather than a multi-role aircraft. Lockheed, General Dynamics, North American Rockwell, Grumman, Fairchild-Republic and McDonnell Douglas all submitted proposals.

December: Both General Dynamics and McDonnell Douglas received CFS contracts These studies were completed by May 1968.

1968 September 30: The Air Force issued a new RFP for the Project Definition Phase (PDP) of the F-X Project. This time the RFP was much more specific on technical details and asked for an aircraft that would be superior in air-to-air combat to any present or projected Soviet-designed fighter. Eight companies responded: Boeing, Lockheed, General Dynamics, North American Rockwell, Grumman, LTV, Fairchild-Republic and McDonnell Douglas.

October 24: The Air Force officially redesignated the F-X as the F-15A

December 30: PDP contracts for what was now called the F-15 program were awarded to North American Rockwell, Fairchild-Republic and McDonnell Douglas.

1969 July 14. The F-15 program office became an independent organizational element reporting directly to the AFSC Commander. ASD continued to

LEFT
F-15C 86-161, of the 390th FS, 366th Wing, Mountain Home AFB, Idaho, was in the penultimate batch of F-15Cs manufactured for the US Air Force. (Rob Tabor)

provide administrative, logistical, and engineering support for the program. Col Benjamin N. Bellis, brigadier general select, appointed as deputy for the F-15.

October 19: Headquarters AFSC designated the F-15 SPO as the Deputy for F-15. All divisions within the program rose to become directorates of the deputate.

December 23: The US Air Force selected McDonnell Douglas as prime contractor for development and production of the F-15 air superiority fighter. The announcement came after an 11-month, seven-day-a-week effort by a proposal team of 1,000 people.

1970 January 1: F-15 development contract F33657-70-C-0300 with McDonnell Douglas became effective. This enabled McDonnell Douglas to begin full-scale development.

February 27: Pratt & Whitney of West Palm Beach, Florida, selected as the F-15 engine contractor.

August 27. The Air Force canceled the AIM-82A Short Range Missile for the F-15.

September 30: Hughes Aircraft Company selected as the subcontractor for the F-15 radar systems.

1971 April 8: F-15 critical design review completed.

June 8: The Air Force and US Navy signed a joint agreement for developing the AIM-9L short-range missile for the F-15 and F-14.

June 18: The Air Force approved the F100 engine design for the F-15.

1972 May 31: Government approval of the F100 engine preliminary flight rating test program.

June 26: The first F-15A (71-0280) was rolled out in a ceremony in St. Louis and christened "Eagle."

July 27: The F-15A Eagle made its first flight successfully and on schedule, taking off from Edwards Air Force Base in California with McDonnell Douglas chief test pilot Irv Burrows at the controls.

October 17: The Deputy Secretary of Defense approved funding for F-15 long-lead items.

1973 February 23: The Deputy Secretary of Defense authorized Fiscal Year 1973 production of the F-15.

February 28: McDonnell Douglas received Department of Defense and Air Force approval to begin work on the first production versions of the F-15A/B Eagle.

March 1: Production approval given for 30 operational aircraft and full production funding.

April 25: The Department of Defense directed the USAF to conduct a complete 150-hour test program on the F100 engine.

July 7: First flight of the two-seat F-15B.

1974 June: The F-15 *Pacer Century* program to evaluate engine durability commenced.

September 18: Representatives from the Deputy for F-15 and Air Force Logistics Command agreed upon January 1, 1980 as the transition date for F-15 management and engineering responsibility. On this date AFLC would assume responsibility from Air Force Systems Command (AFSC).

November 14: F-15A/B Eagles entered operational service with the Air Force's 555th Tactical Fighter Training Squadron at Luke AFB, Arizona. First two Eagles are TF-3 (73-108) and TF-4 (73-109).

1975 February 1: An F-15A Eagle completed its sweep of all eight time-to-climb world records by streaking to an altitude of 98,425ft in under 3.5 minutes.

September: The first F-15 squadron reached initial operational capability.

1976 January: Deliveries of the first combat-ready F-15s went to the Air Force's 1st Tactical Fighter Wing at Langley AFB, Virginia.

March: Using F-15B (TF-2) 71-0291, McDonnell Douglas demonstrated the F-15's capability for delivering air-to-ground ordnance at supersonic speeds. The company stated that more than 13,000 pounds of air-to-surface weapons could be carried on the F-15 without the downloading of any of its air-to-air weaponry.

April: The Air Force authorized use of a common ejection seat in the F-15, F-16, and A-10 aircraft.

May 22: The Deputy for F-15 received the Daedalian Weapon System Award. MajGen Robert C. Mathis, F-15 program director, accepted the Colonel Franklin C. Wolfe Memorial Trophy, symbolizing the achievement

June 30: Tristan J. Keating retired as Director of Systems Engineering for the F-15. He had served the government for 37 years.

September: Fred T. Rall, Jr, received the first Air Breathing Propulsion Award for his contributions to developing the F100 engine. The American Institute of Aeronautics and Astronautics presented the award.

September: F-15B (TF-2) 71-0291 completed a six-country, four-continent world tour. The red, white and blue Bicentennial Eagle made extensive use of specially design conformal fuel tanks during the two and a half month tour and was displayed carrying a combination of air-to-air and air-to-ground weapons.

November 4: F-15B (TF-2) 71-0291, the only red, white and blue F-15, became the first F-15 to surpass 1,000 flight hours. First flown in October 1973, TF-2 made 785 flights to reach the 1,000-hour mark.

November 18: Herbert J. Hickey, Jr, won the Harold Brown Award for engineering F-15 handling qualities.

December 10: The first F-15s were delivered to Israel under *Peace Fox*.

1977 January: The F-15 Production Eagle Package (PEP-2000), a program to increase the aircraft's fuel capacity, began.

April 27: The Air Force deployed the Eagle overseas for the first time when 23 F-15s from Langley AFB, Virginia, flew to Bitburg Air Base in Germany.

May 5: Decision Coordinating Paper 19 increased the F-15 procurement cost from $9.88 billion to $11.68 billion.

May: The Air Force's Flight Dynamics Laboratory announced the Advanced Fighter Technology Integration (AFTI) program. It said two fighters would be modified and used as test beds for integrated and independent technology demonstration. One aircraft would be an F-111 and the second either an F-15 or F-16.

October 1: Responsibility for the F100 engine transferred to the Deputy for Propulsion. The Deputy for F-15/JEPO became simply the Deputy for F-15.

October 18: Program Management Directive (PMD) R-P2060(13)/27130F redesignated the TF-15A as the F-15B.

December 28: The Japanese National Defense Council announced that funds for purchasing 100 F-15s would be in the fiscal year 1978 budget.

1978 July: The United States completed arrangements with Israel and Saudi Arabia for delivery of F-15 aircraft.

August 11: The Air Staff directed AFSC to incorporate an air-start capability into the F-15's F100 engine.

1979 February: The Deputy of Engineering completed an investigation into the problems associated with F-15 vertical fin vibration.

February 26: First flight of the F-15C.

March 19–27: The USAF convened a committee of fuel system experts to examine the F-15 fuel system and assess engineering changes.

June: F-15 Foreign Military Sales to date totaled 108 aircraft worth approximately $2.5 billion.

June: As of this date, McDonnell Douglas had delivered 424 F-15A and F-15B aircraft.

June 19: First flight of the two-seat F-15D.

June 27: The first air combat action with F-15 Eagles took place during a mission with the Israeli Air Force over southern Lebanon. During the air battle five Syrian MiG-21s were shot down, with no losses to the F-15.

September: The Air Force deployed the first F-15 squadron at Kadena, Okinawa.

OPPOSITE
F-15A 75-060 represents the operational history of the Eagle very well. It was one of the first F-15s acquired by the 36th TFW at Bitburg, arriving in June 1977. Replaced by an F-15C, it then served with the 71st TFS, Langley AFB, VA, and is seen here on a deployment to a NATO air base in 1982. Afterwards it served with the 33rd TFW and 325th TTW in Florida, before being retired to AMARC in 1998. (USAF)

FF
AF
75
060

September: As of this date McDonnell Douglas had delivered 28 F-15C and 5 F-15D aircraft.

October 23: Program Management Transfer (PMRT) date of January 1980 extended to October 1, 1982 based on award of last production contract of March 1982.

October 23: Headquarters Air Force directed AFSC to extend the F-15 delivery schedule from fiscal year 1983 into 1984.

1980 May. McDonnell Douglas announced that it had begun modifying F-15B (TF-2) 71-0291 as part of the company-funded Advanced Fighter Capability Demonstrator program.

March 11: Headquarters Air Force revised the delivery and financial schedules of the F-15. Prior to fiscal year 1980 the McDonnell Douglas Corporation had delivered 437 production aircraft. Plans called for the USAF to receive a total of 729 operational aircraft by 1985.

April 15: Col Ronald W. Yates succeeded Col Kenneth R. Johnson as F-15 director.

June: As of this date, sales of the F-15 to other nations totaled 112 aircraft at a cost of $2.6758 billion.

July 8: First flight of F-15B (TF-2) 71-0291 modified by McDonnell as an Advanced Fighter Capability Demonstrator aircraft with expanded air-to-ground as well as air-to-air capabilities.

July 15: Japan accepted its first F-15J Eagle.

December: The McDonnell Douglas Corporation proposed a Strike Eagle two-seat variant of the F-15 with enhanced ground-attack capability. The proposed program involved retrofitting, with improved avionics, the 144 Air Defense Tactical Air Command F-15s, the 206 F-15As and F-15Bs, and the 304 F-15Cs and F-15Ds in the other tactical forces. Additionally, the USAF planned to procure a further 204 F-15Cs and F-15Ds, and 398 F-15Es.

1981 April 28: Following a briefing on this date, the Air Council approved the F-15 MSIP to increase combat capability.

June: F-15 aircraft provided cover when eight Israeli F-16s bombed Iraq's nuclear reactor near Baghdad, in a precision, two-minute strike.

August: The F-15 became operational with the RSAF under *Peace Sun.*

September 17: The Air Force announced plans to procure 1,155 F-15 aircraft along with the previously obtained 20 development airframes.

1982 August 1982–September 1983: Air Force Flight Test Center at Edwards AFB, California, conducted flying qualities tests of an F-15C equipped with conformal fuel tanks. In conjunction with the proposed F-15E dual-role fighter, Edwards' officials also evaluated the F-15C with various air-to-ground stores.

September 29: Warner Robins Air Logistics Center and ASD signed the F-15 program management responsibility transfer agreement. Management responsibility for the F-15A, B, C, and D went to Air Force Logistics Command on October 1, 1982 The F-15 program office retained responsibility for system acquisition and some 94 residual tasks.

1983 February 22: The USAF and McDonnell Douglas Corporation signed a letter contract, F33657-83-C0043, for full-scale development of the MSIP. This program was designed to fulfill the roll of the tactical air forces through an integrated acquisition and modification effort.

July 29: The F-15 Eagle became the first Air Force fighter to amass 10,000 hours of flight testing without the loss of an aircraft.

1984 January: LtGen Thomas H. McMullen, ASD Commander, established a multi-command group under the supervision of the F-15 program deputy director, Col J. S. Smith, to study landing gear deficiencies. The group recommended further configuration changes and improved maintenance procedures.

October 1: Air Force's Flight Dynamics Laboratory awarded McDonnell Douglas a five-year contract to modify F-15B (TF-1) 71-0290 as part of the Short take-off and landing and Maneuver Technology Demonstrator (S/MTD) program.

1985 June 20: Rollout of the first F-15 MSIP Eagle.

June 28: The first two advanced MSIP aircraft were delivered to the 33rd Tactical Fighter Wing, Eglin AFB, Florida.

1986 May: 1,000th F-15 Eagle delivered.

1987 August: While addressing acquisition issues, LtGen William E. Thurman, ASD Commander, stated: "the F-15 requires only two-thirds the maintenance man-hours per flying hour as the F-4 jet it is replacing."

1988 Saudi Arabia and Israel purchase more F-15s under the FMS program.

September 7: The F-15 Agile Eagle S/MTD flew for the first time. Agile Eagle was modified with moveable canards mounted on the forward fuselage, a fly-by-wire flight control system, and larger and heavier landing gear.

1989 May 16: First flight of F-15 Agile Eagle S/MTD with rectangular thrust-vectoring and thrust-reversing exhaust nozzles.

November: Last F-15C delivered.

1990 March 23: First flight of F-15 S/MTD with round, pitch-and-yaw thrust-vectoring nozzles.

1991 August 12. The STOL/F-15 demonstrator aircraft made its last flight, validating operation of its Autonomous Landing Guidance System during a night landing at Edwards AFB, California.

October 1: Merger of System Program Director (SPD) from ASD and F-15 Systems Program Manager (SPM) from Warner-Robins Air Logistics Center. BrigGen Childress served as the SPD.

1992 January 9: The F-15 SPO received the General Bernard A. Schreiver Award in the Air Force Systems Command major program category for the year 1991. This award recognized the SPO for its outstanding support to the weapons system during *Desert Shield* and *Desert Storm*, as well as developing integrated weapon system management for the new Air Force Materiel Command (AFMC).

1996 April 24: The F-15 S/MTD Agile Eagle became the first aircraft to fly supersonically using round, pitch-and-yaw thrust-vectoring nozzles.

1997 August 1: McDonnell Douglas merged with Boeing and began operations as a single company with more than 220,000 employees.

November 21: The Air Force announced the planned deployment of an Air Expeditionary Force (AEF) to Southwest Asia, including 12 F-15C aircraft from Eglin AFB, Florida.

1998 July: Depot maintenance responsibility for the F-15 transferred from McClellan AFB, California, to Robins AFB, Georgia, with the pending closure of the California installation. Programmed depot maintenance had been performed at McClellan since 1991 and other maintenance activities for the weapons system had been performed there before that year.

December 16: A Boeing F-15D Eagle from the 33rd Fighter Wing, Eglin AFB, Florida, became the first F-15 in the Air Force's inventory to log 6,000 flying hours.

1999 December: The Air Force announced plans to equip some frontline F-15C fighters with the APG-63(V)2 AESA radar system. Officials expected this system to significantly increase the F-15C's capabilities while cutting maintenance costs.

2000 February: The F-15 Project Team of the SPO received the Program Executive Office Team of the Year Award for 1999. The award recognized the team's "efforts in managing and executing a highly aggressive $350 million F-15 Active Electronically Scanned Array, or AESA, radar upgrade program."

APPENDIX F

F-15 EAGLE SPECIFICATIONS

Dimensions & Weights

Length:	63ft 9ins
Height:	18ft 8ins
Wingspan:	42ft 10ins
Basic take-off weight:	F-15A 39,400lb (27,700lb) F-15B 39,800lb (28,100lb)
(operating weight[8])	F-15C 42,100lb (28,600lb) 15D 42,600lb (29,100lb)

Motors

Two Pratt & Whitney F100-PW-100, PW-220 or PW-220E turbofan engines with afterburners.

Afterburning thrust:

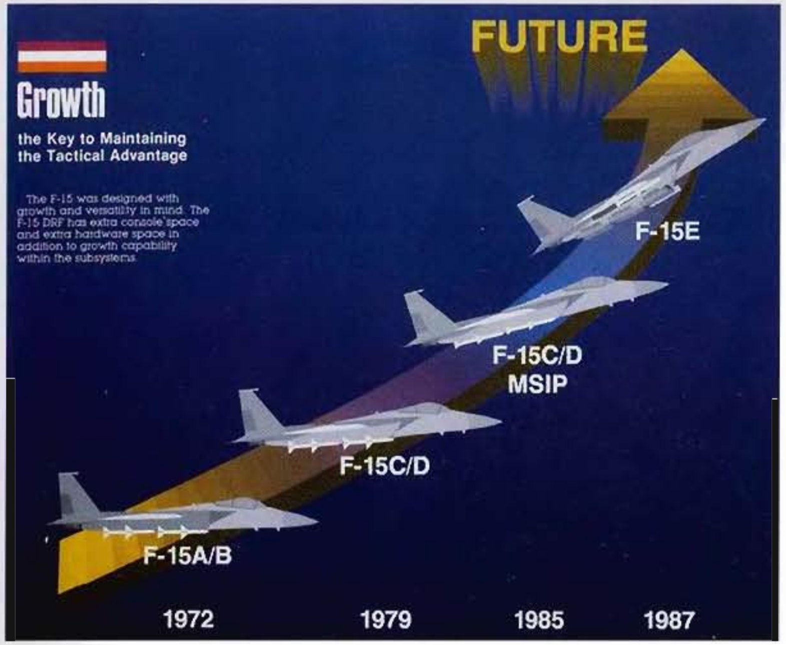
PW-100	23,900lb
PW-220	23,450lb
PW-220E	23,900lb

Performance

Maximum speed	1,875 mph (Mach 2.5) at high altitude
Ceiling	65,000ft

Range

Ferry range, F-15C with three 610US gal drop tanks	2,878 miles
Ferry range, F-15C with three 610US gal drop tanks and CFTs	3,450 miles


Growth
the Key to Maintaining the Tactical Advantage
FUTURE
F-15E
F-15C/D MSIP
F-15C/D
F-15A/B
1972
1979
1985
1987

The F-15 was designed with growth and versatility in mind. The F-15 DRF has extra console space and extra hardware space in addition to growth capability within the subsystems.

ABOVE
MSIP was a major step in McAir's and the Air Force's in-service development of the Eagle. (Boeing)

APPENDIX G
F-15 EAGLE VARIANTS

OTHERS LESS FAMILIAR

In the 30+ years since the F-15 entered service, several experimental or developmental incarnations of the jet have been flown.

STREAK EAGLE (72-0119)

This airframe was used for two weeks from January 16, 1975 to establish the capabilities of the F-15 in a controlled and instrumented environment. Three USAF F-15 pilots' flew the jet to very precise parameters during this time, thereby achieving several speed and climb world records. The aircraft was heavily modified to reduce weight as much as possible. Among the list of items removed were: a generator, speed brake and flap actuators, utility hydraulic system, non-critical cockpit displays and radios, landing and taxi lights, and radar/associated LRUs. The aircraft was a Cat II[8] airframe, and was already 800lb lighter than Cat I aircraft prior to any modifications. In all, the jet was reduced to 1,800lb less than other Block 6 aircraft. The program cost was $2.1 million.

F-15 S/MTD (71-0290)[9]

This was a $117.8 million program awarded to McAir by the USAF in 1984. The total contract cost eventually reached $272 million, and from it was born the F-15 Short take-off and landing/Maneuvering Technology Demonstrator (F-15 S/MTD). The basis for the contract was to test emerging technologies for suitability to the USAF's Advanced Tactical Fighter – the competition between the YF-23 and YF-22, the latter of which emerged victorious. Controllable foreplanes were added,[10] so too were F-15E cockpit switches and displays, F-15E landing gear, and provision for the APG-70 and LANTIRN pods. Most importantly, however, two-dimensional thrust-vectoring nozzles were added to modified PW-220 engines. These nozzles were made from titanium and carbon-fiber and were able to enhance maneuvering, and take-off and landing performance. They could redirect thrust longitudinally by 20 degrees up and down, and could provide full reverse thrust on landing. Finally, they could provide limited amounts of braking thrust while airborne via use of louvers just in front of the divergent/convergent nozzles.

RIGHT
Although still very capable, the APG-63(V)1 was beginning to show its age by the late 1990s when compared with the new range of AESA radars that were then being developed (USAF)

Some 350 hours of ground testing was performed by P&W, revealing that the engines and nozzles were capable and relatively trouble-free.

To make use of the advanced flying control surfaces and systems, a fly-by-wire control system was used to operate the four control channels. The addition of the foreplanes had meant an expanded flight envelope for the NF-15B (as it was known by McAir), and the jet eventually demonstrated an increased capability in several areas: 50 percent increase in roll rate, 30 percent increase in pitch rate, decreased landing rolls, decreased take-off runs and so on In addition to raw performance capabilities which saw the NF-15B pushing the flight envelope, interesting technological innovations were also being tested. One such innovation involved using the AAQ-13 LANTIRN NAV pod and APG-70 in concert to provide steering cues to land at an unplanned alternate airfield. The system was demonstrated to allow the aircrew to patch map an airfield and have the APG-70 automatically provide glideslope steering for a perfect approach. All the while, the pilot referenced the NAV pod to visually confirm what his computers were telling him. It is unclear if this technology has made its way into the F-22, although the absence of a NAV pod certainly makes this seem unlikely. The program ended in 1991 and paved the way for '0291's next testing assignment – ACTIVE.

Advanced Control Technology for Integrated Vehicles (ACTIVE) was a program started in 1996 based on a similar premise to the S/MTD venture, to test and develop technologies for operational use in the next generation of airframes. ACTIVE saw joint Agencies (NASA, P&W, USAF and McAir) installing a revised thrust vectoring system onto two PW-229s Aside from the different engines, the other main difference was the multi-directional nozzles: +/-20 degrees in any direction (known as Pitch/Yaw Balance Beam Nozzles). These nozzles lacked a braking thrust/thrust reversing capability and the availability of vectoring at high Mach numbers (Mach 2).

NASA

NASA has owned several F-15s:

71-0281 was used in December 1975 to test the thermal tiles used by the Shuttle Orbiter. It was handed back to the USAF in 1983.

74-0141 was an F-15B used by NASA from 1994 as the Aerodynamic Flight Facility. As NASA 836, it was used to carry a flight test fixture (FTF) on its center pylon. The FTF houses research systems, materials for testing and instrumention. A good package example is the X-33 Thermal Protection System. Tested during FTF II, the system calibrated, monitored and instrumented the materials destined for the X-33 at various flight velocities, altitudes, temperatures, aerodynamic loadings etc.

F-15A NASA 835 was acquired on January 5, 1976, and was operated as the Flight Research Facility. Originally 71-0287, it was the eighth production F-15A and has been employed in a variety of guises since then – it is probably the hardest worked of all NASA's F-15s. NASA originally used 835 to test and develop future propulsion systems, aerodynamics, integration, control systems, instrumentation, and flight test techniques (among other things) in 1976. Then, in 1982, it was used to test DEEC for the PW-220 version of the F100. It demonstrated massive performance increases and went on to be the test bed for the F100 IPE. In 1986 it tested the Advanced DEEC Engine Control System (ADECS), a system used to evaluate and control the stall margin of the engine under different operating parameters. Among the list of results were a decrease in fuel consumption by 15 percent at constant thrust settings, improved rate of climb by 14 percent and up to 24 percent increase in acceleration (the DEEC tests had already demonstrated an increase in acceleration by up to 41 percent). Most importantly though, no stalls were encountered, not even with the most heavy handed and aggressive use of thrust and maneuver.

Leaving the DEEC theme, NASA 835 then moved on to HIDEC (Highly Integrated Digital Electronic Control), a system designed to use computers to detect loss of, or degraded use of, control surfaces. It would then reconfigure the remaining control surfaces to compensate. Simultaneously, it would alert the pilot of the failure and generate a new, real time flight envelope to help the pilot keep the aircraft flying. Aircraft 835 tested and demonstrated the Self-Repairing Flight Control System (SRFCS) in 1989. This was a similar program to HIDEC, but one which also offered analysis of failures other than those of the flight control surfaces. Electrics, hydraulics and mechanical systems were all monitored by the SRFCS, which would then make the changes necessary to reconfigure failed systems and keep the jet flying. 1990 saw NASA's workhorse become involved in the Performance Seeking Control (PCS) program; designed to optimize engine performance and ensure safe operation of the engines through digital monitoring of failures and digital control of inlets, nozzles and flight controls.

NASA 835 ended its career with NASA flying as the PCA (Propulsion Controlled Aircraft). A series of crashes caused by loss of flight controls had prompted NASA to begin a program to determine whether a system could be developed to maintain control of an aircraft by simply altering thrust settings on a single

OPPOSITE
As budgets shrink and flying hours come at a premium there has been significant investment in ground-based training tools. The F-15C community can now use the latest distributed mission trainers to fly high-fidelity combat missions on the ground. These Boeing-developed tools can be linked electronically to allow pilots at one Eagle base to fly combat against other pilots in other Eagle squadrons anywhere in the world. (Boeing)

ABOVE
The F-15 Short take-off and Landing/Maneuvering Technology Demonstrator (F-15 S/MTD). The basis for the S/MTD contract was to test emerging technologies for suitability to the USAF's Advanced Tactical Fighter. (USAF)

engine. Initial results showed that it was certainly possible to maintain control in pitch with one engine, though asymmetric application of thrust from two engines was necessary to change heading and induce roll. Dryden and McAir took initial results, ran simulations and added a simple device to the cockpit: a two-thumbwheel control panel – one thumbwheel for required aircraft flight path, the other for bank angle. Subsequently, the pilot used the thumbwheels to "fly" the aircraft, as they controlled engine thrust via computer algorithms put together by NASA and McAir. The aircraft was flown down to less than 10ft above a runway at 150-190KIAS using these thumbwheels, and successful, hands-off landings were made at Edwards AFB, California.

ABBREVIATIONS & ACRONYMS

A/B	Afterburner
A/G	air-to-ground
AAC	Alaskan Air Command
AAFCE	Allied Air Forces Central Europe
AAI	air-to-air interrogator
AAR	air-to-air-refueling
ACEVAL	Air Combat Evaluation
ACMI	Air Combat Maneuvering Instrumentation
AD	Active Duty
ADC	Air Defense Command
ADC	Aerospace Defense Command
ADTAC	Air Defense Tactical Air Command
ADWC	Air Defense Weapons Center
AESA	Active Electronically Scanned Array
AFB	Air Force Base
AFDT&E	Air Force Development Test & Evaluation
AFLC	AF Logistics Command
AFPE	Air Force Preliminary Evaluation
AFS	Air Force Stations
AFSC	Air Force Systems Command
AIMVAL	Air Intercept Missile Evaluation
AIU	avionics interface unit
AMRAAM	Advanced Medium-Range Air-to-Air Missile
ANG	Air National Guard
AOR	Area of Responsibility
ARI	aileron rudder interconnect
ASAT	anti-satellite
ASC	Air Support Command
ASCC	Air Standards Coordinating Committee
ATAF	Allied Tactical Air Force
ATC	Air Training Command
ATEGG	Advanced Turbine Engine Gas Generator
ATO	Air Tasking Order
AUP	Avionics Upgrade Program
AW&CS	Airborne Warning & Control Squadron
AWACS	Airborne Warning And Control Systems
BDA	battle damage assessment
BFM	basic fighter maneuvers
BP	Basic Proficiency
BST	Boresight
C3	Command, Control & Communications
CAOC	Combined Air Operations Center
CAP	combat air patrol
CAS	control augmentation system
CC	central computer
CDP	Concept Development Package
CDT&E	Contractor Development Test & Evaluation
CFS	Concept Formulation Study
CFT	Conformal Fuel Tank
CinC	Commander in Chief
CMD	countermeasures dispensers
CPT	cockpit procedures trainer
CRC	control and reporting centers
CRP	control and reporting posts
CSAF	Chief of Staff of the Air Force
CW	Control Wing
DACT	Dissimilar Air Combat Training or dissimilar air combat tactics
DASH	Display And Sight Helmet
DBS	doppler beam sharpening
DBSS	Debriefing Support System

DCA	Defensive Counter Air
DCP	Development Concept Paper
DEEC	digital electronic engine control
DEW	Distant Early Warning
DLZ	dynamic launch zone
DO	Director of Operations
DoD	Department of Defense
DOR	Chief of Requirements, or more formally, Director of Requirements
DSP	digital signal processor
DTM	data transfer module or digital transfer module
ECCM	electronic counter-countermeasures
ECM	electronic countermeasures
ECP	engineering change proposal
ECS	environmental control system
EID	electronic ID
EM	Energy Maneuvering
EWWS	Electronic Warning Warfare Set
FAA	Fleet Air Arm
FAIP	First Assignment IP
FDL	Fighter Data Link
FIG	Fighter Interceptor Group
FIS	Fighter Interceptor Squadron
FMC	fully mission capable
FMS	foreign military sales
FNG	Fucking New Guy
FOT&E	Follow-on Operational Test & Evaluation
FRYAF	Federal Republic of Yugoslavia Air Force
FSD	full scale development
FWIC	fighter weapons instructors course
FWS	Fighter Weapons Squadron
FWW	Fighter Weapons Wing
GCI	ground control intercept
GD	General Dynamics
GE	General Electric
G-LOC	g-induced loss of consciousness
GM	General Motors
GMTI	selectable ground moving target indicator
HDTWS	high-data Track While Scan
HIS	horizontal situation indicator
HMD	helmet-mounted display
HOBS	high off-boresight
HUD	heads up display
IADS	integrated air defense system
ICBM	intercontinental ballistic missile
ICS	Internal Countermeasures Set
IDF/AF	Israeli Defense Force/Air Force (IAF)
IFF	identification friend or foe
IMU	inertial measurement unit
INS	inertial navigation system
IOC	Initial Operational Capability
IOT&E	Initial Operational Test and Evaluation
IP	instructor pilot
IRAF	Iraqi Air Force
JASDF	Japan Air Self Defense Force
JEPO	Joint Engine Project Office
JFS	jet fuel starter
JHMCS	Joint Helmet Mounted Cueing System
JTF	Joint Test Force
JTIDS	Joint Tactical Information Distribution System
LTV	Ling-Temco-Vought
MC	mission capable or Mission Commander
MFD	multifunction display
MIDS	multi information distribution system
MiG	Mikoyan-Gurevich
MPC	Military Personnel Center
MPCD	multi-purpose color display
MR	mission ready
MRA	maritime reconnaissance aircraft
MSIP	Multi-Stage Improvement Program
MTBF	mean time between failure
NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organization
NCTR	Non-Cooperative Target Recognition
NFZ	No-Fly Zone
NVG	Night Vision Goggles
NVN	North Vietnam
OCA	Offensive Counter Air
OFP	operational flight program
ORI	Operational Readiness Inspection
OSD	Office of the Secretary of Defense
OWS	overload warning system
P&W	Pratt & Whitney
PAA	Primary Assigned Aircraft
PACS	programable armament control set
PD	pulse-Doppler
PLO	Palestine Liberation Organization
PoW	prisoner of war
PRF	pulse repetition frequency

PSP	programable signal processor
PTC	pitch-trim compensator
PTM	practice training missile
QRA(I)	Quick Reaction Alert (Interceptor)
RAF	Royal Air Force
RAM	Raid Assessment Mode
RCP	radar control panel
RCS	radar cross section
RDP	radar data processor
RFP	request for proposal
RLG	ring laser gyro
ROC	Required Operational Capability
RSAF	Royal Saudi Air Force
RTAFB	Royal Thai Air Force Base
RTB	return to base
RTS	Return to Search
RTU	Replacement Training Unit
RWR	radar warning receiver
SA	situational awareness
SAC	Strategic Air Command
SARH	semi-active radar homing
SEAD	Suppression of Enemy Air Defenses
SECAF	Secretary of the Air Force
SG	Surgeon General
SLBM	submarine-launched ballistic missile
SOC	Sector Operations Centers
SOF	supervisor of flying
SPO	Systems Project Office
SRP	sortie production rate
SS	Super Search
Stan/Eval	standardization and evaluation
sts	so to speak
TAC	Tactical Air Command
TD	target designator
TDP	Technical Development Plan
TES	Test and Evaluation Squadron
TEWS	Tactical Electronic Warfare Suite
TFG	Tactical Fighter Group
TFTS	Tactical Fighter Training Squadron
TFTW	Tactical Fighter Training Wing
TFX	Tactical Fighter Experimental
TRW	Tactical Reconnaissance Wing
UN	United Nations
UPT	Undergraduate Pilot Training
USAF	US Air Force
USN	United States Navy
USSR	Union of Soviet Socialist Republics
VG	variable geometry
VID	visual identification
VS	Vertical Scan
VSD	vertical situation display
WEZ	weapons engagement zone
WIC	weapons instructors course
WoW	weight-on-wheels
WSO	weapons systems officer

ENDNOTES

CHAPTER 1: THE F-X COMPETITION

1 General Curtis LeMay commanded SAC from October 1948 to June 1957. He was the USAF Vice Chief of Staff from July 1957 to June 1961, and Chief of Staff, US Air Force (CSAF) from June 30, 1961 to January 31, 1965.

2 Tu-20 was initially thought to be the designation of the Tupolev Tu-95 design, a four-engined swept-wing turboprop bomber. The correct design bureau and service designation was Tu-95.

3 A highly decorated WWII bomber hero, General Sweeney had held numerous SAC command positions, including that of leading the prestigious Eighth Air Force, before being appointed in October 1961, by General LeMay himself, to head TAC. Sweeney attempted to "professionalize" TAC, that is recreate TAC in SAC's image, a process known throughout the fighter community as "SACumcizing" the fighter command. He was finally replaced by a "fighter general," Gabriel P. Disosway, in July 1965, and the long road back to tactical competence began.

4 F-4H-1F BuNo 145307 became part of the collection of the Smithsonian National Air and Space Museum at the Paul Garber restoration facility in Suitland, MD.

5 One USAF study of fighter-bomber effectiveness in SEA determined that the F-4 had about the same bombing accuracy as the older F-105 Thunderchief: 323ft (about 100m) average miss distance.

6 The AF-specific F-4D had the improved, but still limited, Westinghouse APQ-109A radar in the nose.

7 The USAF's kill:loss ratio in fighter-v-fighter air-to-air combat over NVN during Operation *Rolling Thunder* was 2.1:1. During the later 1972 *Linebacker* operations, it was 1.75:1. Overall the ratio was 1.96:1. Additionally two A-1E Skyraiders and one RC-47 were shot down by NVN MiG-17s and an RF-101C was lost to a MiG-21 during *Rolling Thunder*, making the total score ratio even worse. Two additional USAF victories were credited to B-52 tail gunners during *Linebacker II* (no MiGs were actually shot down). No B-52s were lost to MiGs.

8 Twenty MiG-21F-13 "Fishbed-Cs" (23mm gun, "High Fix" range-only radar, and two AA-2 "Atoll" IR missiles) began arriving in late 1965 and 30 MiG-21PF "Fishbed-Ds" (no gun, "Spin Scan" target acquisition and fire control radar – 15nm search/10nm track – and two "Atolls") began arriving in April 1966.

9 While the USN had a very similar initial experience in air-to-air combat over NVN, their approach to solving the problem was much different, improving training and experience in addition to improving their F-4s. The dismal showing during Operation *Rolling Thunder* resulted directly in the establishment of the famous (and Hollywood enhanced) "Top Gun" Program, and a correspondingly large increase in kill:loss ratios when the fighting resumed.

10 Sources: Victories are from Futrell, R. Frank, et al, *Aces and Aerial Victories: The United States Air Force in Southeast Asia 1965–1973*, The Alfred F. Simpson Historical Research Center, Air University; and the Office of Air Force History, Washington DC, 1976. Losses are from Hobson, Chris, *Vietnam Air Losses: United States Air Force, Navy and Marine Corps Fixed-Wing Aircraft Losses in Southeast Asia 1961–1973*, Midland Publishing, Hinckley, UK, 2001.

11 The VPAF admits the loss of 134 MiGs in aerial combat and claims 320 US aircraft shot down by MiGs.

12 Dorr, Robert F., *F-15 Eagle*, *World Air Power Journal*, Vol. 9, AIRtime Publishing, summer 1992, pp.39, 40.

13 It should be remembered that the US intelligence community initially misidentified the new interceptor as the "MiG-23." Its outstanding aerodynamic, plus persistent reports that the "MiG-23, a very different aircraft, had entered high rate production," created a hugely inflated Soviet "bogeyman" that took years and Viktor Belenko's September 6, 1976 defection to deflate and put into its proper and realistic context.

14 Fairchild and Republic had merged by this point (1964), and this company was to morph again into Fairchild Hiller by the time of the final RFP.

15 McDonnell Aircraft Company merged with Douglas Aircraft Corporation on April 28, 1967 to become McDonnell Douglas Corporation.

16 This concept is easily replicated with sound waves, the most common example being that of a fast approaching train sounding its horn and the observer hearing the increasing rise in pitch, as opposed to the descending wail of the horn after it passes and speeds away.

17 Stevenson, James Perry, *McDonnell Douglas F-15 Eagle*, Aero Publishers, Inc., Fallbrook, CA, 1978, p.18.

18 The actual weight difference between the single-seat F-15A and two-seat F-15B turned out to be 400lb.

19 It is noteworthy that VG wings eventually fell from favor. The F-111 encountered a number of problems with its wing through box which almost led to its demise and certainly left it with a poor reputation which it never really managed to leave behind – such problems in the early days of F-X could have spelt disaster.

20 Fairchild Hiller, Grumman, Lockheed and North American all stayed in the running following selection of McDonnell Douglas and General Dynamics, but only because each company financed its own research. In the event, GD was eliminated early and Fairchild Hiller and North American put forth detailed technical proposals to compete with the McDonnell Douglas entry in May 1968.

21 The Fighter Mafia eventually had its way, the result of which was the General Dynamics (now Lockheed Martin) F-16 Fighting Falcon.

22 SD interview with Paul Homsher, Boeing, St. Louis, June 2006.

23 Homsher had worked as operations manager for the Gemini spacecraft program, Malvern had been project manager for the F-4, and William Blatz, the other deputy general manager alongside Homsher, was engineering manager for the Gemini B spacecraft program.

CHAPTER 2: THE MCDONNELL DOUGLAS 199-B DESIGN

1 The USAF reserved the right to cancel the project if it went over 145 percent of target cost ($936.5m).

2 *Airscoop*, Volume XXIX, No. 1, January 1970.

3 60lb/sqft at combat load (eight missiles and 60 percent fuel) approached that of the USAF's last "dogfighter," the F-86 Sabre (56lb/sqft) and was 25 percent less than the F-4E's wing loading of 80lb/sqft.

4 Dobronski, Joe, *A Sky Full of Challenges, The Autobiography of McDonnell Douglas Test Pilot Joe Dobronski*, self-published, p.127.

5 The F-15 was about the same size as the F-4 because it was required to fit inside the same first generation hardened aircraft shelters (HAS), commonly known as "Tab Vees," that housed the 36th TFW Phantoms at Bitburg. Consequently, it was only 4ft 5in. wider in wingspan (but required flip up "rails" to be built into the HAS floor to guide the F-15 backwards into the shelter without scraping a wingtip against the interior wall) and just one foot longer. Despite being larger dimensionally, it was lighter, because of the extensive use of titanium, and boron and graphite epoxy composites.

6 As the fabrication specialists referred to themselves.

7 *Spirit*, McDonnell Douglas, July 1973, p.4.

8 The HUD was designed and built by McDonnell Douglas Electronics (and was designated AVQ-20), the VSD by Honeywell and the HSI by Collins Electronics.

9 The radar, armament control set, air data computer, attitude heading reference system, horizontal situation indicator, HUD, signal data recorder, RWR, inertial navigation unit, VSD, built-in test panel, data transfer module, avionics status panel, and, originally, lead computing gyroscope.

10 This was the main reason Hughes' radar was selected over the Westinghouse competitor.

11 The original APG-63 consisted of a radar set control panel in the cockpit, an antenna in the nose and seven line replaceable units (LRUs) behind it. Through the huge advances in computer and electronics technologies in the 1970s and 1980s, it experienced quantum leaps in capability while at the same time being reduced in size to only four LRUs. See Chapter 10, "Improved Eagles."

12 The angular difference between the target's longitudinal axis and the F-15-to-target line of sight.

13 The original APG-63 was gradually superseded from 1984 onwards by the APG-70, APG-63(V)I and (V)II radars. See Chapter 10 "Improved Eagles" for discussion of the components and key differences between the original and the newer radars.

14 Unlike the F-4 Phantom the F-15 trigger only fired the gun. In the F-4 the trigger squeeze shot off all air-to-air ordnance, missiles and gun alike, depending on what was selected. Many a former F-4 driver, early in training, took plenty of gun camera film when trying to make simulated missile firings against his adversary.

15 The Navy wanted a 27,000lb thrust engine, the added power providing an extra margin of safety during carrier operations for the much heavier F-14B. The Air Force needed a 22,000lb thrust motor. Less thrust equals less stress on components and thus less frequent overhauls. The TF30, for which the USN settled, was rated at 20,840lb thrust, condemning the 59,700lb Tomcat to being a terminally underpowered dogfighter, until some aircraft received GE F110 engines much later in its career.

16 For an unclassified discussion of *Combat Tree*, see Michel III, Marshall L., *Clashes: Air Combat over North Vietnam 1965–1972*, Naval Institute Press, 1997.

17 Bay 5 was the fifth LRU-mounting bay built into the airframe, numbered from Bay 1L and 1R just behind the radar bulkhead, through the other ground-accessible LRU racks, to Bay 5 behind the pilot. Because the ICS LRUs contained highly classified EW data, they were removed from the aircraft before going cross country to other bases and nations. With Bay 5 empty, it became a convenient "trunk" (American) or "boot" (British) for storage of pilot's luggage, spare parts, cases of German wine or beer, wooden butcher's blocks from Aviano, or bentwood rockers from Spain. One story has it that an Eagle pilot even flew his motorcycle home to the States, broken down into easily loadable components, in Bay 5, during a rotation for *Red Flag* or WSEP (Weapons System Evaluation Program).

18 The ALQ-135 would require additional development before it was ready for installation in the F-15. It reached operational status in 1978, whereupon it was installed in Eagles coming off the assembly line at St. Louis and retrofitted to Eagles already operating with Air Force squadrons across the United States.

19 As discussed in Chapter 5, the F-15 was prone to enter unrecoverable spins at high AoA if there was significant asymmetric wing loading. Placing the 800lb ALQ-119 near the wingtip was just such a spin-inducing condition, so Stations 1 or 9 were almost never used by combat units. Instead it was usually mounted to the centerline, with two external fuel tanks under the wings.

20 SD interview with Gary Jennings, Boeing, St. Louis, March 2002.

21 *Eagle Talk*, McDonnell Douglas Internal Publication, 1984, Vol.1.

CHAPTER 3: TEST & EVALUATION

1 Initially FOT&E used "LA"-coded 58th Tactical Fighter Training Wing (TFTW) jets on a rotational basis rather than being assigned specific tail numbers for long durations. The 422nd FWS was assigned its own aircraft in 1977.

2 When foreign F-15 customers joined in the testing program it was renamed as the F-15 Combined Test Force (CTF).

3 SD interview with Irv Burrows, Boeing, St. Louis, June 2006.

4 Ibid.

5 *Spirit*, McDonnell Douglas, June 1984, p.3.

6 *Eagle Talk*, McDonnell Douglas Internal Publication, 1984, Vol.1, p.6. (Originally printed in *Product Support Digest*, 1973).

7 CAS works the stabilators and rudders, but has no authority over the ailerons.

8 SD interview with Irv Burrows, Boeing, St. Louis, June 2006.

9 Ibid.

10 *Eagle Talk*, McDonnell Douglas Internal Publication, 1984, Vol.1, Page 6. (Originally printed in *Product Support Digest*, 1973).

11 Later disposition details sourced from van Toor, Jurgen, "F-15 Eagle," *Scramble*, Dutch Aviation Society, 2006.

12 Most printed and electronic sources erroneously give the first flight date for F-9 as October 20. Our original source material and a double-check with Larry Merritt, Boeing's historian, confirms the date was October 2.

13 The General Electric M61A1 had been used in USAF aircraft since 1954 and therefore there was no reason for the USAF to include its developmental costs into the accounting for an airframe being fielded almost 20 years later.

14 *Aerospace Daily*, March 20, 1973, p.106.

15 *Eagle Talk*, McDonnell Douglas, 1984, Vol. 1, p.6. (Originally printed in *Product Support Digest*, 1973).

16 Ibid.

17 According to Ethell, Jeff, *F-15 Eagle*, Specialty Press, 1981.

18 Interestingly, after all the consternation over ensuring that a gun was included in the design, all of the USAF's aerial victories with the F-15 have been scored with missiles.

19 Where the missile is carried repeatedly but never fired. The stresses of repeated captive-carry missions were known to adversely affect the Sparrow's reliability.

20 Compared to 140 for the F-4.

21 From LtCol Robbins' *F-15 IOT&E Flights for First Wing Release*, a briefing to TAC/CC, as quoted by LtCol William H. Mott's Air War College paper *F-15A versus F/A-22 Initial Operational Capability*, Maxwell AFB, November 2005.

22 By the end of AFDT&E, the 6512th TS had acquired all 20 preproduction aircraft, but by the end of 1975, because they were not production standard airframes, they had been farmed out to various sources. Of the eight Category II jets, one (F-17) became the "Streak Eagle" (then placed on permanent display at the National Museum of the US Air Force, Wright-Patterson AFB, OH) while five were brought up to production standard and sold to Israel (F-12, F-14, F-15, F-16 and F-18, curiously enough) in the first Peace Fox sale and the other two became a ground trainer (F-13) at Lowry AFB, CO, then Sheppard AFB, TX, and a gate guardian (F-11) at Rome ADC, NY.

23 *Air Force Test and Evaluation Center History*, January 1–December 31, 1976, as quoted by LtCol William H. Mott's Air War College paper *F-15A versus F/A-22 Initial Operational Capability*, Maxwell AFB, November 2005.

24 Stevenson, *McDonnell Douglas F-15 Eagle*, p.87.

25 BOMARC – short for Boeing-Michigan Aeronautical Research Center, where it was designed – was a high-altitude, high-Mach SAM originally designated IM-99 (Interceptor Missile-99 from being numbered in the USAF's fighter series, an illustration of the service's fascination with interceptor technology instead of real fighters in the late 1950s/early 1960s). After the DoD-directed consolidation of military designation systems, in June 1963 it was retitled CIM-10 for Combined (meaning in both USAF and RCAF service) Interceptor Missile. Retired in April 1972, the remaining examples became target drones – the "Q-for-drone" being substituted for the "I" in the designation – for tests of other air defense missile and weapons systems. Notably, the CIM-99B employed the world's first PD search radar, the Westinghouse AN/DPN-53.

26 Ethell, *F-15 Eagle*, p.43.

CHAPTER 4: F-15 SERVICE ENTRY

1 The total number of US PoWs in NVN came to 591, of which 25 were civilians. Some of the 566 military PoWs had been released earlier as pawns in NVN political peace overtures. The total 527 reflects those returned to the US in Operation *Homecoming*, which ended on March 29, 1973.

2 TF-15A/73-0108 was redesignated as an F-15B on December 1, 1977 and remained at Luke AFB with the 58th/405th Tactical Training Wings (TTW – tailcode "LA") until April 1986. The venerable "first B-model" was assigned to 128th TFS, Dobbins ANGB, GA, until June 1991 when it was returned to Luke AFB to be placed on permanent static display.

3 The 555th began life in 1942 as a medium bombardment squadron flying Martin B-26 Marauders. It saw action in the European Theater of Operations (ETO) from July 30, 1943 to May 3, 1945, flying from bases in England, France, and Belgium. It transitioned to the Douglas A-26 Invader and became a light bomber squadron before being deactivated in November 1945. Reactivated at McDill AFB, Florida, on January 8, 1964, it became a member of the 12th TFW and trained on the F-4 Phantom II before deploying to Okinawa in March 1966 to begin operations in SEA. It was a component of the 8th TFW at Udorn and Ubon from February 25, 1966 until joining the 432nd TRW.

4 Michel III, Marshall L., *Clashes – Air Combat Over North Vietnam 1965–1972*, Naval Institute Press, Annapolis, MD, 1997. Historic data from the Vietnam War is quoted from p.286.

5 Anderegg, C. R., *Sierra Hotel – Flying Air Force Fighters in the Decade After Vietnam*, Air Force History and Museums Program, Washington, DC, 2001, p.163.

6 Each USAF unit was assigned a primary Designated Operational Capability (DOC), a secondary DOC, and in some cases, such as nuclear-capable units, a tertiary DOC. The DOC assigned determined the kinds and amounts of training sorties to be flown in each capability, with the Primary DOC receiving the lion's share of sorties allocated. Air superiority was one of the possible DOCs, and in a wing of three squadrons, normally one squadron would have air superiority as its primary DOC, while the others carried it as a secondary or tertiary DOC and concentrated instead on air-to-ground skills. To limit prospective Eagle Drivers to being just from those air superiority F-4 squadrons was obviously overly restrictive.

7 In fact, experience soon showed that some highly experienced F-4 pilots who had become heavily dependent on their WSOs had great difficulty adapting to the single-seat mentality and having to do everything for themselves.

8 This was certainly not the last time the USAF/SG attempted to influence the Eagle community with an arbitrary and bogus proposal. In the late 1970s they recommended to the Air Staff that only pilots with natural 20/20 or better vision be allowed to fly high-performance fighters. In other words, once an experienced F-15 or F-16 pilot required glasses, he would no longer be qualified to fly his fighter. This of course was shot down in flames by the F-15/F-16 experienced LtCols and Cols serving in the Air Staff, many of whom had just become old enough to require glasses, and at the same time looked forward to returning to the TAF as squadron and wing commanders.

9 Anderegg, *Sierra Hotel*.

10 One of the Lts eventually became a LtGen and commander of the 11th Air Force in Alaska, another became a MajGen. Obviously MPC selected the highest caliber individuals for the honor of being the first UPT graduates to fly the Eagle.

11 The class included Bob "Cowboy" Autrey, Mark "Magic" Beesley (later BrigGen), Steve "Brownie" Brown, Brian Duffy, Chris "Potshot" Goetsch, Mark "Cobra" Holmes, Bob Knauff (later a MajGen in the ANG), Branford "Knife" McAllister, and Mike "Boa" Straight. The FAIP was Capt Rick Tuseth.

12 The avionics and engines maintenance requirement was one of the few that McDonnell Douglas was unable to meet. While many of the airframe design features were aimed at meeting the 11.3MMH/FH goal, faulty LRUs and engines caused the rate to average 35MMH/FH by 1980, three times the requirement.

13 Dorr, R. F., *Wings of Fame*, Vol. 4, AIRtime Publishing, p.36.

14 The only tactical fighters to be based at Langley since the establishment of TAC were the F-86s of the 4th Fighter Wing in 1949–50 and the F-84s of the 20th Fighter-Bomber Wing in 1951–52. Considering this represented four of the 30 years that TAC had been HQ'd at Langley, it conformed to and exceeded the "fighter pilot rule" of a point having to be at least 10 percent true to be valid. Therefore, Langley AFB was indeed the "traditional home of tactical fighters."

15 In WWII the 56th Fighter Group, "Zemke's Wolfpack," was the 8th Air Force's top scoring fighter unit with 665.5 kills. It was based at Boxted, England, for most of the war.

16 This aircraft led a long and eventful history, being assigned to the 43rd TFS at Elmendorf AFB, AK, and the 199th FIS, HI ANG, Hickam AFB, HI. Finally, it was flown to the 32nd FS at Soesterberg AB, Netherlands, as an ABDR asset. It went to the Royal Netherlands AF Museum at Soesterberg in the markings of F-15C 77-0132, the number of the "Wolfhounds" flagship during most of that unit's history as an Eagle squadron.

17 Actually the first F-15 to arrive at Langley for the 1st TFW was TF-15A 74-0137, landing on December 18, 1975, but being a "two holer" (more frequently called a "tub" or "the family model") bound for a distinctly "single-seat" unit, it did not warrant any fanfare. It

was assigned initially as a maintenance trainer to prepare the wing's flightline technicians to receive their first "operational" jets.

18 The early F-15 units were initially required to maintain two DOCs: air superiority, a more offensively oriented capability, and air defense, which is oriented as per its title.

19 The 461st had previously been the 4461st Combat Crew Training Squadron. Upon activation with its new designation, it inherited the lineage and honors of the 461st Fighter Day Squadron which flew F-86F Sabres, followed by F-100 Super Sabres, at Hahn AB, West Germany, from February 1956 until being disbanded in 1959.

20 The 433rd was another unit with a rich legacy in the air-to-air arena. Formed in May 1943 as part of the 475th Fighter Group (545 aerial victories total), the "Satan's Angels" swept the skies of the Southwest Pacific of Japanese fighters and bombers using the Lockheed P-38 Lightning. The unit's most notable and highest scoring ace was Major Thomas B. McGuire, Jr, who was second only to Major Richard I. Bong, with 38 kills.

21 Sadly, "Jake" Jacobsen and his backseater were the first Eagle fatalities when Jacobsen's F-15B (75-0085) was lost while flying Air Combat Maneuvering on the Nellis Ranges on December 6, 1977.

22 F-15A 75-0042 stayed with the 433rd until being stored at Robins AFB, GA, due to lack of engines in 1980. It returned to service in October 1981, going to the 461st TFTS at Luke, then to the 325th TTW at Tyndall in 1988, serving with both the 2nd and 95th TFTSs until being retired to AMARC on September 10, 1992.

23 The F-15As were 75-0043 (arriving November 30, 1976), 75-0054 (December 21, 1976) and 75-0055 (January 1, 1977). The two TF-15As were 75-0084 (December 13, 1976) and 75-0085 (January 1, 1977). 75-0084 was still flying in 2006, with the 40th FTS (46th TW – tailcode "ET") at Eglin AFB, FL. The other surviving jets are now in AMARC or serve as ABDR trainers.

24 Another of the 433rd FWS's initial allotment of aircraft was also lost in a midair collision. 77-0054 was eventually assigned to the 128th FS of the Georgia ANG and was lost on December 17, 1993, crashing into the Atlantic off Brunswick, GA, after a midair collision with an Arkansas ANG (184th FS, 188th FW) F-16A (82-0927). The F-16 pilot was killed in the accident.

25 C. R. Anderegg was a veteran of SEA in F-4s, commanded the F-15-equipped 525th TFS at Bitburg AB, West Germany, in the 1980s and retired after 30 years of service, as a full Colonel, to become the Chief Historian of the US Air Force.

26 The "sort" is the process whereby each member of a flight takes responsibility for engaging a specific enemy radar contact, thus ensuring the maximum number of enemy aircraft are targeted. This is done at a pre-briefed, or Wing-standard, range and for typical enemy formations the lead Eagle pilot will engage the lead MiG or the one on his side of the formation, Eagle number 2 will take the second MiG/one on his side, etc. Conducting the sort is typically done over the radio, when the lead Eagle pilot calling out his intended target ("EAGLE ONE, sorted the southern MiG, 15,000 feet"), followed by each other member of the flight doing the same ("EAGLE TWO, sorted on the northern trailer, 17,000 feet," etc.) until each Eagle pilot has singled out his own individual target. "Missing" the sort refers to Eagle pilots inadvertently taking on the same MiGs, leaving one or more MiGs to get to the merge untargeted. At this early stage of F-15 BVR employment tactics, LtCol S. R. "Shad" Dvorchak, an AIMVAL/ACEVAL evaluator, observed that in 140 test 4 v 4s there was "Not a single case of perfect sorting." But it takes practice to get close to perfect in such a dynamic and deadly environment. Consequently there were some excellent (and not-so-excellent) "real life" examples of how the sort should be conducted during the 1991 Operation *Desert Storm*.

27 Watt, LtCol (Ret) Barry D., *Clausewitzian Friction and Future War*, Institute for National Strategic Studies, Fort McNair, Washington, DC, October 1996, Chapter 9.

28 *No-Win War at Dogbone Lake*, *US News and World Report*, January 9, 1978, p.56.

29 Ethell, Jeff, *F-15 Eagle*, Specialty Press, 1981, pp.48, 102.

30 In an evaluation for the Deputy Undersecretary of Defense, Dr. Walter B. LaBerge, in February 1981, Dr. Thomas S. Amlie assessed: "The AIMVAL/ACEVAL exercises were badly flawed and very expensive. The flaws... had to do with an unrealistic scenario [VID required], incorrect assumptions on missile capabilities, and somewhat arbitrary rules on equipment carriage... Due to the aggressive and competitive nature of fighter pilots, this quickly changed from a good-natured evaluation of hypothetical missile concepts to as close as one can get to combat without actually firing weapons." As reported by LtCol William H. Mott, in his *Air War College Paper F-15A versus F/A-22 Operational Capability*, Air University Press, Maxwell AFB, AL, November 2005, page 14.

31 Anderegg, *Sierra Hotel*, p.161; Ethell, *F-15 Eagle*, p.102.

32 Hall, George, *Top Gun – The Navy's Fighter Weapons School*, Motorbooks International, Osceola, WI, 1991.

33 Watts, *Clausewitzian Friction and Future War*, Chapter 9.

34 Ethell, *F-15 Eagle*, p.102.

35 In fact, Col Boyd was one of the principal offenders against his own warning. Having overstepped his own considerable expertise and acumen, Boyd had left the Air Force to ally himself with a rogue OSD (Office of the Secretary of Defense) analyst, a Democrat Congressional Staffer, and an investigative reporter to become an outspoken critic of the USAF's post-Vietnam force development, still pushing for the small, light, simple fighter that he had advocated while in the Air Force. For a full analysis of Boyd's team of "Reformers" see Kross, LtCol Walter, "Military Reform: Past and Present," *Air University Review*, July–August 1981.

36 Rube Goldberg (1883–1970) was a Pulitzer Prize–winning American cartoonist most famous for his designs of over-engineered contraptions created by kludging together otherwise unrelated pieces of gear to perform a simple function in an indirect and convoluted way. W. Heath Robinson (1872–1944) was his British equivalent, a cartoonist who drew fantastical comic machinery.

37 Anderegg, *Sierra Hotel*, p.161.

38 Personal experience was that it was only successful one or two times out of ten, but in the high-stakes "game" of air combat, just one success justified "Eagle Eye"'s continued use until other means of long-range ID became available.

39 It is important to recall that the apparent fulfillment of this group's dreams, the General Dynamics F-16 Fighting Falcon, was not a product of AIMVAL/ACEVAL, but instead was a result of the Carter Administration's fait accompli ultimatum to the USAF that if it wanted a replacement for the F-4 for the 1980s, it would be the F-16A or nothing at all. Fortunately GD designed this light fighter with sufficient growth potential that it became another world-beating USAF combat aircraft, especially once AMRAAM was fielded – and in its later forms it was not cheap either.

40 An unclassified paragraph in the Robins AFB *Air Logistics Center History for FY1997*, Chapter 5 *Aircraft and Logistics Management*, explained that NCTR: "enabled the pilot to identify and target enemy aircraft [italics added] before he was detected or before the enemy could employ his weapons."

CHAPTER 5: HAPPINESS IS ... GEASLES AND A SWEATY G-SUIT

1 The explanations and details regarding the other four fighters discussed at the end of this chapter that were contemporaries of the F-15 "back in the day" are taken largely from conversations (usually in flight/fight debriefs or over some beers at the bar) with their pilots (and in the case of the Tomcat, their RIOs) and reflect no independent research on my part.

2 The jets typically carried 940 rounds of 20mm TP (training practice) ammunition so that their center of gravity was in its normal place and so that they were ready to "shoot the dart"

(aerial gunnery practice involving another aircraft – usually an F-4 – towing an aluminum foil covered honeycomb arrowhead, called a "dart") for gunnery practice on other missions.

3 The battery in the F-4 was located beneath the WSO's ejection seat. If the battery ever went "dead" – such as from a pilot leaving the battery switch in the ON position after shutdown – the entire rear canopy and ejection seat would have to be removed to replace the battery. This was not uncommon for crews to do, if they forgot, or if they found themselves at a particularly inviting "out base" and wanted to stay there a while.

4 While the UHF control head and IFF switches were located atop the instrument panel just beneath the HUD, the main UHF and IFF panels – with many more dials and settings – were located on the left console within easy reach.

5 Since the wing of the F-15 was already highly cambered and its nose would be high at slow speed in any event, flaps were initially thought to be unnecessary.

6 The F-15 stick force sensor was the first ever fly-by-wire system and an enhanced version of it was used in the prototype of the flight control system for the General Dynamics F-16A's wholly fly-by-wire system.

7 The CAS was what enabled the Israeli Air Force F-15B to be able to recover safely to base after losing a wing in a midair collision with an A-4 during DACT.

8 At least in the 20th century. For a subjective comparison with contemporary types of fighters, see *DACT: A Subjective Comparison of Contemporary Fighters* later in this chapter.

9 In aerodynamic terms, drag is that property (resistance) which impedes an aircraft's flight through the air and it is countered by thrust. Drag has two components: parasitic (nominally the frontal area of an aircraft) and induced, which is that drag produced by the work done by the wing generating lift. The sum of these two types of drag (total drag) is balanced by thrust. In cruise flight the throttles are set to maintain a certain, stable airspeed and this power setting is that which produces the same amount of thrust as the aircraft has total drag. The more cambered a wing is, the more induced drag it produces for a given AoA. Thus the F-15, with its highly cambered swept wing, generates huge amounts of induced drag because it generates huge amounts of lift (rotating the aircraft to high AoA under heavy *g* loads) When the combination of parasite and induced drag exceeds the amount of thrust produced by the engines, airspeed begins to decay, and the aircraft begins to decelerate.

10 Michel III, Marshall L., *Clashes – Air Combat Over North Vietnam 1965–1972*, Naval Institute Press, Annapolis, MD, 1998, p.287.

11 The Navy version of the AIM-9L had its seeker cooled by a bottle mounted in the wing pylons of the F-14 Tomcat.

12 Anderegg, C. R., *Sierra Hotel – Flying Air Force Fighters in the Decade After Vietnam*, Air Force History and Museums Program, Washington, DC, 2001, p.163.

13 The early F-15A/Bs at Luke had no ICS in Bay 5 or RWR scopes in the cockpit. In place of the ALR-56A RWR scope on the upper right side of the instrument panel, there was a large "frequency card" providing a ready reference of the UHF frequencies needed to negotiate through ground, tower, departure, area and approach control.

14 One of the chief examples of "cheating" in a practice air-to-air engagement was to use the F-15's two UHFs to your advantage. If your wingman aborted before arriving in the DACT airspace, you could conceal his absence by simulating his standard responses with the second radio. On UHF No. 1: "TIGER 01, check." On UHF No. 2: "Twoop!" [A supposed TIGER 02 confirming his readiness]. UHF No. 1: "VIPER 01, TIGER here, two F-15s in the north, ready to play." Response: "VIPER copies, two F-16s in the south here, ready to play." UHF No. 1: "TIGER 01, go channel 12 [the DACT inter-flight frequency]" UHF No. 2: "Twoop!" Thus VIPER flight (a pair of F-16s) would believe that two Eagles confronted them, not just one. This charade was maintained through the normal sequence of radar bearing, range and altitude (*BRA*) calls simulating sharing targeting information with the wingman, and the lone Eagle would arrive at the merge with both Viper pilots scanning the sky for the second F-15. Wary to avoid a "belly shot" from the unseen Eagle as they started maneuvering, they would hesitate, if only momentarily, before beginning the hard turning of the visual fight. Often this hesitation was just enough for you to carve into a shooting position on one Viper (usually the one going straight ahead, tasked with finding the phantom wingman), eliminate him, and then you'd have a good old 1 vs 1 rodeo on your hands! Then the trick was to extend out and separate from the fight before the "dead guy" regenerated (kill ratio 1:0). If done well, the Viper drivers wouldn't know there was only one of you present until the debriefing.

15 For instance, the fuel boost pumps in the fuselage tanks could not pump fuel to the engine feed tanks as fast as the F100s, in "full grunt" (maximum afterburner), consumed it, and thus the motors could drain the feed tanks dry while there was still gas in the fuselage (or even wing) tanks, causing double engine flame out. Unfortunately, once the engine fuel pumps were cavitated (filled with air) they blocked the fuel tank pumps from forcing the fuel into the engines and a restart was impossible. Warning sensors announcing "fuel low" were soon installed to prevent repeated losses.

16 It is important to understand and appreciate that this flippant disregard was rarely applied to flying regulations or directives. This is because almost all flying rules exist for a specific purpose or reason – usually to ensure you return to the earth safely – so they made sense and most were written in blood, in that they were there because someone paid with his life by doing otherwise. While commanders took the typical fighter pilot's lax regard for dress regulations as some statement of apathy toward flying rules, this was rarely the case.

17 Since exaggeration and hyperbole are staple ingredients of fighter pilot storytelling, the guiding principle for recounting any tale of airborne buffoonery at the Friday Beer Calls was that they must be "at least 10 percent true" to be considered factual. These tales of woeful flying were mandatory at any fighter pilot initiation (Mission Ready ceremony) and most squadrons used the practice of assigning the next week's most distasteful ground duties to the hapless one who exhibited the most airborne buffoonery of the prior week. Thus there was great motivation to not have your flying embarrass you.

18 HQ TAC was against the use of tac callsigns as anything but a social title because the ever-cautious Stateside command had the idea that it fostered, and indicated, a lack of flight discipline if used in the air. In fact when two USAFE F-4Es from Ramstein were participating in a WSEP (Weapons System Evaluation Program) AIM-9 shoot at Eglin AFB in the early 1980s – and one shot down the other instead of the QF-102 drone – the TAC Mishap Board made sure to find the F-4 crews' use of tac callsigns to be a cause of the accident. Just how using a tac call sign over the radio can result in one Phantom pilot mistaking another F-4E for a pilotless, single-engined, delta-winged drone driving around in a steady circle was not explained in the Mishap Board's report.

19 American fighter aircraft – and European and Soviet fighters by association and comparison – are generally grouped into four generations from 1945 through the end of the 20th century. The first generation encompasses the earliest jet fighters, usually with centrifugal flow turbojets, rudimentary fire control (radar) systems (if any), and largely machine-guns and unguided rockets as weapons (F-80, F-84, F-86, F-89, F-94). The second generation are transonic/supersonic fighters commonly called the 'Century Series' and commonly use axial flow afterburning turbojets, basic single function radars, and largely 20mm cannon and IR-guided missile armaments (F-100, F-102, F-104, F-105, F-106). The third generation is exemplified by the growth in electronic technologies requiring second crewmembers, twin engines, effective (if not reliable) radar missiles and various aeronautical design innovations such as boundary layer control and variable geometry wings (F-4 and F-111). The fourth generation emphasizes extremely powerful afterburning turbofan engines, computer integration into the weapons system, additional sensors, and enhanced aerodynamic agility such as is seen in the F-15 and F-16. In this rubric, the F-14 can either be viewed as the last third generation US fighter, or a transitional one bridging the gap between third and fourth generations.

20 Additionally, the F-14 used AIM-7E-2 and -3 Sparrows, somewhat improved over the "Great White Hope" of the Vietnam War, but not enough to duel effectively with the APG-63/AIM-7F combination.

21 Having flown a back-seat orientation flight in an F1B on a 2 v 1 mission over the Mediterranean off Marseilles, I witnessed first-hand the limitations of the Mirage's systems. In three engagements, even with GCI, the two-ship found the single-ship target only once.

22 While not necessarily the most appropriate tactic to use facing two F-15s, this was done "for training purposes" so that the Eagles would also split, resulting in two 1 v 1s which is the best scenario for comparing your own jet with an adversary aircraft.

23 This would require one F-15 to break off the initial attack to meet the threat of the inbound "Flogger," and thus the 4477th "Red Eagles" had again done a great job of getting us into two 1 v 1s to maximize the personal experience of fighting a "Flogger" and comparing the F-15 with the MiG-23 first-hand.

CHAPTER 6: ACTIVE DUTY EAGLE UNITS IN THE COLD WAR

1 In another mass deployment that would soon become a keynote feature of American fighter units, 89 36th FBW F-84Es flew the 5592 mile non-stop across the Atlantic in 13 hours, refueling multiple times from KB-29Ps.

2 The "Bulldogs" served in WWII as the 525th Fighter Bomber Squadron flying North American A-36A Invaders and Republic P-47 Thunderbolts in the North African and Mediterranean Theaters of Operations. During the build-up for the Cold War the squadron returned to Europe in August 1946 as part of the 86th FBW and began flying Republic F-84Es. It transitioned to F-86s and became an FIS in 1954. Although still a component of the 86th, the Squadron was moved to Bitburg (and became a tenant of the 36th FBW) as USAFE spread its air defense squadrons among its bases. In January 1959, the "Bulldogs" became the first USAFE unit to operate the F-102 and ten years later it converted to the F-4E and was formally assigned to the 36th TFW (and became a TFS) while the rest of the Wing operated F-4Ds for some time to come. The "Bulldogs" were always refered to as the "five-two-five," not the "five-twenty-fifth."

3 In the Eifel dialect of the German language, Bitburg is pronounced "Bitbush," leading to the affectionate term of reference as "the Bush" and to the title of the monthly 36th TFW Stan/Eval Newsletter as the Bush Rag.

4 MR means that a pilot is qualified to conduct all the missions assigned to that unit. MC means the pilot is capable of flying all the missions but not necessarily to the proficiency or currency levels required of an MR pilot. MC familiarity was intended to help wing staff members make better decisions regarding the unit's missions and operations.

5 To make room for the Eagles, the E-model Phantoms of the 36th were used to establish three new USAFE squadrons: the 313th TFS at Hahn, 480th TFS at Spangdahlem, and 512th TFS at Ramstein, so a large increase in American air power in Europe resulted from the Eagles' arrival.

6 The 53rd TFS "Tigers" followed the "Bulldogs," standing down in May 1977 and deploying from Langley to Bitburg in July. The 22nd TFS "Stingers" began conversion at Langley in August and returned to Bitburg in October.

7 At this time NATO's European Command was organized into three regions – North, Central and South – facing the Warsaw Pact, with other commands to protect lines of communications across the North Atlantic and English Channel. The Central Region encompassed all of West Germany, Belgium, the Netherlands and Luxembourg and contained the air forces of these nations (Luxembourg is used as the "holding company" for NATO E-3s), plus those of Canada, the UK and USA.

8 SOC III at Boerfink, near Ramstein, controlled 36th TFW activities under the callsign COPPER RING.

9 "Tango Scramble Two" meant "training scramble, launch two aircraft." If LA01 and 02 aborted because one of them had a problem, LA01 would pass the lead to the other element, led by LA03 and they would launch on the scramble. Upon them landing the 36th TFW had one hour to bring all four jets back up to QRA(I) five-minute alert status.

10 The 58th TFTW was redesignated as the 58th Tactical Training Wing on April 1, 1977 and formed its third squadron, the 550th TFTS "Silver Eagles", on August 25 that year.

11 A "Bunyip" (called "Bunyap" by the Americans) was a fierce mythical monster of aboriginal lore – a screaming demon thought to haunt waterholes and caves. The natives of Horn Island, off Cape York, the northernmost tip of Australia, painted its fearsome image on their shields to protect them in battle and help them destroy their enemies. When the 7th FS deployed 12 P-40s to Horn Island in April 1942, the pilots of the unit quickly recognized the psychological benefits of this talisman – especially since their P-40s were seriously outclassed by the more nimble Japanese "Oscar" and "Zeke" fighters opposing them – and adopted the "Bunyap" as the squadron's emblem, at least one of them painting the image on the tail of his Warhawk, where Japanese pilots were sure to see it.

12 The order of conversion of the 49th's squadrons was: 7th TFS beginning in October 1977, 8th TFS in January 1978, and 9th TFS in April 1978.

13 512th FDS, previously based at RAF Manston, England, was the unit's earlier designation.

14 LtCol Lucas had shot down a MiG in SEA and eventually became the 36th TFW DO (Director of Operations) and USAF Inspector General.

15 At the time, the main (09/27) runway at Soesterberg was undergoing repair, so QRA(I) was conducted out of the third generation HASes (Nos 625 and 626) between the main runway and the "Queen's Runway" (13/31).

16 At this time, and until 1992, the Luftwaffe was prevented from participating in the Air Policing of FRG airspace. In readiness for actual combat – the Air Defense Role – the Luftwaffe had a pair of F-4F Phantom IIs on five-minute alert with JG 71 "Richthofen" at Wittmundhafen.

17 The Bitburg scramble klaxon sounded like a long blast of an air horn, while the one at Soesterberg was more like that of a European police car: "bee bop, bee bop, bee bop."

18 The "Beak" was an eastern salient, shaped like a bird's beak, in the IGB pointing into East Germany (GDR), hence the name.

19 To intervene is to pull up alongside an intruding aircraft, give the appropriate ICAO-standard signals and then lead the intruder to land at a specified NATO airfield where it, the crew and any passengers can be secured by military forces.

20 Eglin's first Eagle turned out to be the longest surviving F-15B flying in any active duty unit. 77-0156 remained at Eglin for only a year before being transferred to the 49th TFW at Holloman and later – November 1989 – it joined the 325th TTW at Tyndall AFB, Florida, finally being retired on September 22, 1995.

21 Like the 1st TFW before it, the 33rd stood up two squadrons (the 58th converting in January 1979 and the 59th in April) but used a third (the 60th TFS) as a "schoolhouse" to prepare a frontline wing (18th TFW) for deployment to its overseas station. The 60th TFS finally converted to the F-15 in the second half of 1980.

22 The first Kadena squadron to convert was the 67th TFS "Fighting Cocks" beginning at Eglin in July 1979 and returning to Okinawa in September. Next, the 44th "Vampires" started conversion at Eglin that October and deployed back to Kadena in January 1980. That same month the 12th TFS "Dirty Dozen" began its conversion and returned home in April.

CHAPTER 7: DEFENDING THE HOMELAND: AIR DEFENSE AND ALASKAN EAGLES

1 The 43rd is one of the older USAF units, but not as "illustrious" as most. As the 43rd Aero Squadron it arrived in France too late to participate in WWI. In WWII it spent the entire conflict defending the Panama Canal Zone with P-39s and P-40s as part of the 16th Fighter Group. During SEA the unit was reactivated as an F-4C unit (part of the 12th TFW) before deploying to Clark AB, Philippines, and Cam Rahn Bay AB, SVN, for the last half of 1965. Its assets were assumed by the 559th TFS and the 43rd TFS "flag" returned to MacDill AFB, FL, to be

re-created as an F-4E squadron. On July 15, 1970 the Phantom-equipped 43rd moved to Elmendorf AFB to relieve the 317th FIS, whose Convair F-102A Delta Daggers were by now completely obsolete. In recognition of the 43rd's early tradition as a fighter training unit, this designation was chosen for the first F-22 Raptor training squadron at Tyndall AFB.

2 The 54th Fighter Squadron was the unit most closely associated with defending Alaska, especially during the Japanese invasion of the Aleutian Islands in WWII. Flying another twin-engined, twin-tailed fighter – the Lockheed P-38 Lightning – the "Leopards" left their parent 55th FG at the end of May 1942 to deploy to Elmendorf and become the primary air defense unit guarding Anchorage. In later months, the unit supported US forces retaking Kiska and Attu Islands, being based at Adak, Amchitka, Shemya and Attu Islands as the war progressed. After WWII it served from 1952–60 as the 54th FIS at SAC's Ellsworth AFB, North Dakota, flying F-84s, F-86s and F-89s, and was resurrected in May 1987 to return to its original role of defending Alaska.

3 The ancestor of the 3rd Wing originated in 1921 when the US Army Air Service had only three operational units – the 1st Pursuit Group, 2nd Bombardment Group and 3rd Attack Group. The 3rd flew various attack aircraft, including the Douglas A-24 Dauntless, early in WWII, fighting in New Guinea, the Solomons and the Philippines, finishing the war as a light bomber group flying North American B-25 Mitchells. Additionally it served in the Korean War from beginning to end, flying Douglas B-26 Invader light bombers. During the Vietnam War the 3rd TFW flew F-100 Super Sabres, primarily in the close air support role from Bien Hoa AB, SVN, from July 1965 to March 1970. Afterwards it moved to Clark AFB, the Philippines, until the US withdrew from the Philippines in 1991 after the Mt. Pinatubo eruption destroyed the air base.

4 The 19th FS actually had a less "illustrious" history. Originally it was the 19th Aero Squadron during WWI, first as a training unit at Kelly Field, TX, then as a maintenance unit in France. It was reactivated in Hawaii and served as an air defense unit until deploying to Saipan with P-47Ds in 1944. After WWII it was deactivated until 1982, when it flew F-16s at Shaw AFB, SC, but for only a year.

5 Much to the displeasure of the MiG-killing "Nomads," they received in turn the older, more worn "MSIP-Cs" from Bitburg as that base closed and sent two squadrons-worth of jets (22nd and 525th TFSs) home to the States. As they said of tired old racehorses, "These have been ridden hard and put away wet."

6 The unit began its history as the 48th Aero Squadron, an airfield construction outfit in WWI and training unit between the wars. In WWII it was reconstituted as a part of the 14th Pursuit Group flying P-38s in the North African, Sicilian and Italian campaigns. Inactivated in 1949, it was reactivated as a FIS on November 1, 1952 at Grenier AFB, NH.

7 ADC had long before adopted orange flight suits so that a survivor could be more easily spotted from the air in the event of an ejection over snow-covered territory – a distinct possibility when most missions were flown over snowy Canada. As in all military organizations with a unique feature, this set ADC interceptor pilots apart from aircrews of other commands who had to wear the standard USAF issue green flight suits. Of all the changes conferred upon them with the assimilation into TAC, this was probably the one most regretted by long-time "dyed in the wool" interceptor pilots.

8 The 318th began its history as a part of the 325th FG and flew P-40s, P-47s and P-51s in the MTO. After WWII it was reactivated as a night-fighter squadron flying P-6, F-82 Twin Mustangs, F-94A jet interceptors, F-89Ds, F-86Ds, F-102s and F-106s. It served at Hamilton Field, California; Thule AB, Greenland; and Presque Isle, Maine, before finally settling in August 1955 at McChord AFB, Washington.

9 As part of this major shift of moving F-15C training from Arizona to Florida was completed, that most traditional USAF air-to-air unit of modern times, the "World Famous and Highly Renowned Triple Nickel," first became an F-15E air-to-ground training squadron, then was closed at Luke and reopened at Aviano AB, Italy, as one of the two F-16 squadrons that were moved from Ramstein AB, West Germany. (The other became the 510th FS, a former A-10 unit.) The 405th TTW retained the 426th "Killer Claws" and 461st "Deadly Jesters," until the closure of the 405th TTW when the movement of F-15C training to Tyndall was complete.

10 But more commonly known as the "Horney Horses" because of their emblem.

11 The 95th "Bonecraniums" began its existence in 1942 as a component of the 82nd Pursuit Group. It flew P-38s in the North African and Italian campaigns, being credited with 199 Axis aircraft destroyed in aerial combat. As an ADC unit beginning in 1952, it flew F-94s, F-86s and F-102s from Andrews AFB, MD, and F-106s from Dover AFB, DE, until finally moving to Tyndall as a training unit in September 1974 to fly T-33As as targets for the F-106s.

12 Generally speaking, the Tu-95 "Bear-A" through "E" and "G" and "H" were Soviet air force heavy bomber, cruise missile launcher and reconnaissance platforms. (A portion of the total number of Tu-95RTs "Bear-D" and Tu-95MR "E" reconnaissance aircraft – 37 "Ds" and 12 "Es" to be exact – were Soviet navy machines.) The Tu-142 was an altogether new design, but using many Tu-95 airframe components it is visually almost identical. The Tu-142 was designed and built specifically for the Soviet naval aviation as a long-range anti-submarine ("Bear-F") and submarine radio relay ("Bear-J") aircraft. The ultimate Tu-95 "Bear-H" bomber was based on the Tu-142 airframe.

13 Iceland was not the first cold clime for this traditional interceptor squadron. Established on January 15, 1941 as the 57th Pursuit Squadron (Interceptor) flying Bell P-39 Airacobras, it moved to Alaska in 1942 to battle the Japanese during the Aleutian Islands campaign, then returned to the "lower 48" as a P-51A fighter training unit until disbandment in May 1944. Resurrected in 1953 it trained on the two-seat, twin-engined, radar-equipped Northrop F-89C Scorpion before deploying to Keflavik Airport (which became NAS Keflavik in June 1961).

14 Normally one or two E-3s would be deployed to Keflavik from Tinker AFB, Oklahoma, and serviced by the 960th Airborne Warning and Control Support Squadron based there.

15 The 57th FIS maintained three F-15Cs on five-minute alert around the clock.

16 A highly experienced fighter pilot with 2,388 hours in the F-15 alone, LtCol Kline was later the commander of the 54th TFS at Elmendorf AFB, Alaska, before retiring.

17 In fact, if we did lock up the Tu-95 inside about 20nm, the 18ft diameter prop disks were such huge radar reflectors we could see the radar scintillating, that is "dancing" from one propeller disk to another, usually going across all four before reversing to repeat the dance, telling us that the target had four sets of propellers, thus confirming it was a "Bear."

18 Actually, legend has it that the scheme was concocted at the 57th's squadron bar, famous throughout the fighter force as the "WIF," although no one seems to be able to remember why. Brain cells lost due to alcohol poisoning are suspected as the cause.

19 The last gasp of the Russian "Bears" probing US air defenses occurred on September 16, 1999 when a pair of Tu-95s was detected headed toward the Alaska coast. F-15s were scrambled, but the "Bears" turned tail at about 90-miles range, well before entering US airspace. The last time the 57th FIS saw a "Bear" was late in June that same year when two Tu-95s came down the GIUK Gap. They were intercepted by a total of four F-15s and were escorted through the Iceland MADIZ as they circumnavigated the island clockwise before returning to Russia.

CHAPTER 8: AIR NATIONAL GUARD EAGLES

1 *Eagle Flight Leader*, Vol. 4, No. 3, August 1985.

2 To clarify: USAF maintenance standards are the same for AD, ANG and AF Reserve units. It is how they are applied, time available and the experience of the maintainers that make the difference. Aircraft can either be flown or fixed. With a "ute" rate (utilization rate) of at least 1.0 an active duty 24PAA squadron flies an average of 24 or more sorties per day, whereas an ANG squadron flies about half that much, giving its maintainers twice as much time to keep their jets in top-notch condition. The vast experience of ANG technicians means they are more efficient, taking less time to do so, too.

3 In a twist of cruel irony, the 122nd TFS was ordered to pass all of its 1973-build Eagles to Israel in 1991. They were replaced by decrepit 1977-build jets, and the maintainers of the Louisiana ANG had to start all over again from square one!

4 The 154th Wing is a "composite unit" made up of the 199th Fighter Squadron (17 F-15As and two F-15Bs), 204th Airlift Squadron (eight C-17s) and 203rd Air Refueling Squadron (eight KC-135Rs). Consequently it is completely equipped, as well as being conveniently located, to deploy the fighter squadron to any trouble spot in the Pacific. This undoubtedly was a significant reason for the selection of the 199th FS to be the first ANG squadron to transition to the F-22 Raptor.

5 There are actually two categories of "full-time" personnel in ANG units: the Active Duty Guard Reservist (AGR) and the "Guard Technician," who is a US Government Service (civil service) employee. These two categories typically make up 25 percent of a unit's pilot force with the "traditional Guardsman" (who serves one weekend a month and two weeks during the summer and flies occasionally during the week) making up the remaining 75 percent. For example, originally the 199th FS had seven full-time and 24 part-time Guard pilots. Five more full-time AGR pilots were added to the roster when the Air Sovereignty Alert commitment was added to the 199th's tasks following the 9/11 terrorist attacks.

6 The 102nd FW records that its aircraft flew 2,388 sorties from September 11, 2001 until February 2002, accruing more than 3,750 flying hours in the process.

7 "BRAC 2005," www.globalsecurity.org/military/facility/nas-jrb-no.htm.

CHAPTER 9: FOREIGN MILITARY SALES EAGLES

1 Israeli losses were: in the Six Day War: 46 aircraft; in the War of Attrition: 35 aircraft; and in the Yom Kippur War: 115 aircraft (including 35 F-4s, 55 A-4s, 12 Mirages and eight Super Mystères).

2 Peace Fox I consisted of AFDT&E airframes F-12 (72-0114/No. 620) and F-14 (72-0116/No. 622) transferred from the 6512th Test Squadron, and F-15 (72-0117/No. 644), all delivered on December 10, 1976. The fourth AFDT&E airframe purchased was F-16 (72-0118/No. 646), which came from the 555th TFTS. All four were scheduled for delivery to Tel Nof AB, Israel, on December 10, but this last jet had to turn back to Sigonella AB, Sicily, due to a mechanical problem. This diversion resulted in the rest of the formation arriving late, and the reception ceremony extending into the Sabbath and precipitating the fall of the Rabin Labour Government. Repaired, F-16 arrived at Tel Nof later that month. Additionally, pre-production F-15A F-18 (72-0120/No. 649) was delivered in 1982 as a replacement for an F-15A (serial number unknown) that was lost in August 1981 to birdstrikes. All IAF pre-production aircraft retained their original small speedbrakes. Most sources report only four AFDT&E airframes, but these fail to include either airframe F-12 or F-18 depending on the source researched. This mistake is generally caused by an error in the now Boeing delivery lists which confuses AF76-0120 for AF72-0120.

3 The 19 F-15As had serials 76-1505 through 1523 and 2 Block 16 F-15Bs, 76-1524 through 1525. These aircraft are readily identifiable by the lack of the ALQ-128 pod atop the left vertical stabilizer.

4 The Rafael IR missiles are numbered in sequence even if the name changes. The Shafrir (or Shafrir 1) was the first Israeli AAM and was generally a copy of the short-range AIM-9B but with a larger diameter (15cm) rocket motor, warhead and seeker section. The Shafrir 2 was an improved version, analogous to the USAF/USN AIM-9D. The Python 3 was a much more powerful medium-range IR missile with an all-aspect capability. It had a wider field of view and better off-boresight targeting capability, more powerful rocket motor and large delta canards making it generally superior to the US AIM-9L. The Python 4 added a helmet-mounted sight targeting capability.

5 Jenkins, Dennis R., *Warbird Tech Series Vol 9: McDonnell Douglas F-15 Eagle*, Specialty Press Publishers, North Branch, MN, 1997, p.80.

6 The IAF had been operating mixed-type formations for ten years, with the Kfirs adding firepower while the F-4Es or F-15s provided "air picture" radar information to the very limited (range-only radar) Kfirs.

7 Called *Dayas* (for kite) in Hebrew, the IAF E-2Cs normally operated off the coast, over the Mediterranean Sea, because their radars were cluttered with ground returns when operating over land.

8 Eitan Ben-Eliyahu was the first commander of 133 *Tayeset* and had just passed the squadron to Benny Zinker the month before, moving up to take over the Weapons Department of the IDF/AF staff, but still flew as an emergency posting (EP) pilot with his old squadron. The No. 2 *Baz* was flown by the Flying School Fighter Training Squadron Commander, Maj Moshe Melnik, and No. 4 was piloted by the unit's senior deputy commander, Yoel Feldsho. It is noteworthy that Ben-Eliyahu commanded the IDF/AF from 1996 to 2000.

9 Feldsho's wingman, Guy Golan, also fired an AAM at the same target and initially Golan and Eshel shared the victory. However, the IDF/AF later decided that Eshel should have full credit for the victory, the only one for the IAI Kfir fighter.

10 Jenkins, *Warbird Tech Series Vol 9: McDonnell Douglas F-15 Eagle*, p.80.

11 The French originally named the project Osiris after the ancient Egyptian "god of the dead," and although it soon became known by the more popular Osirak, Saddam Hussein named the reactors Tammuz, after the month of the Islamic calendar during which the Ba'ath Party came to power in Iraq in 1968.

12 Fourteen of the Mk 84s hit the target. The sixth F-16's bombs fell wide because the target was becoming obscured by smoke, dust and debris in the air due to the previous detonations. Coming in from a different direction, jets seven and eight had no difficulty obtaining further hits. Additionally, two of the 14 bombs that hit the reactor failed to explode.

13 This SEAD campaign was also known as Operation *Artzav-19*. *Artzav* is Hebrew for Mole Cricket, which is believed to be a nickname or codename for Arab SAMs, the number "19" denoting the number of SAM batteries to be put out of commission during the operation.

14 The SA-2 "Guideline" was a medium-to-high altitude, relatively long range (21nm), moveable strategic SAM made famous in combats with USAF F-105s and F-4s over North Vietnam. The SA-3 "Goa" was a fixed-site, medium-to-low altitude, medium range (13nm) strategic SAM used for defending targets in the rear areas. The SA-6 was a mobile (mounted on a tracked vehicle), medium-to-low altitude, medium-range (16nm) tactical SAM designed to protect forward armored units in highly mobile, offensive operations. One SA-6 battery consisted of three vehicles each mounting three missiles each, plus a radar vehicle carrying the "Straight Flush" tracking radar and a missile resupply vehicle. The SA-6 was very highly respected by the Israelis since its surprise introduction in the Yom Kippur War had accounted for most of the 115 warplanes lost in that conflict.

15 These were ground-launched, remotely piloted versions of the USAF AQM-34L air-launched reconnaissance drone operated by the IDF/AF's 200 *Tayeset* based at Palmachim AB. In action over Lebanon eight of them were lost in the first six months of operations. In one of the few confirmed Syrian aerial victory claims and a superior feat of Arab airmanship, a MiG-23MF shot down a Firebee on June 6, 1982, at the beginning of Operation *Peace for Galilee*.

16 The campaign was named Operation *Peace for Galilee*.

17 Beaufort Castle was built by the crusaders in the first half of the 12th century.

18 The *Delilah* was an Israeli Military Industries re-engineering of the Northrop MQM-74 Chukar subsonic target drone originally produced for the US Navy, of which a quantity was purchased by Israel in the late 1970s. The *Delilah* was ground-launched and powered by a small turbojet, had a programable flight path autopilot and (if it survived) was recoverable by parachute. It was operated by 146 and 155 *Tayesets*, based at Ramon AB. The *Keres* (Hebrew for Hook) was a development (specifically for the IDF/AF) by General Dynamics of its AGM-78C Standard ARM (an anti-SAM missile developed for use by USAF Wild Weasel aircraft). It was mounted in triplets (in boxes like the Patriot SAM) on M809A1 five-ton trucks and was operated by 153 *Tayeset* based at Palmachim AB and later

by 248 *Tayeset* based at Hatzor. The *Ze'ev* (Hebrew for Wolf) was an Israeli army short-range, surface-to-surface missile employed by specific IDF/GF artillery units.

19 Cooper, Tom, "Floggers in Action: Early MiG-23s in Operational Service," *Air Enthusiast* No. 100, July/August 2002, p.61.

20 These are losses admitted by the Syrian air force (SyAAF) for June 9. Two of the ten were reported to have crashed into the Lebanon Mountains after diving into a cloud deck in an attempt to escape destruction by IAF F-15s. These were credited by the IAF to the F-15s and 133 *Tayeset* in general, (bringing their total MiG-21 "kills" for the day to seven) but not to any specific IAF F-15 pilots. Three MiG-21s were shot down by F-16s.

21 The SyAAF reports the loss of two MiG-23MS "Flogger Bs" and three MiG-23MF "Flogger Es" on June 9. One MiG-23MS pilot was killed, the rest ejecting safely. SyAAF "Floggers" claimed four IAF aircraft shot down.

22 In total, the IAF claimed 22 Syrian aircraft destroyed and no losses. The SyAAF admitted the loss of 16 fighters and claimed to have destroyed one Kfir, one F-4E and two F-16s by MiGs. Syrian news agencies and Soviet propaganda reported 26 Israeli aircraft shot down, but even if this is close to the truth it undoubtedly includes many *Delilah* decoy drones shot down by SAMs.

23 This tactic had no effect since the Israelis knew that the MiG-25PN's "Foxfire" radar had an extremely limited look down capability and unless the "Foxbat" dived down considerably it provided no real threat to the Israeli fighters engaging Syrian formations at lower levels, and thus could be ignored. IAF E-2C Hawkeyes kept close tabs on the MiG-25s to ensure this did not occur.

24 Despite initial disparities between the opposing sides' claims, according to Syrian sources the Syrian air force reported losing 85 aircraft in the period June 6-11, with 27 pilots killed and eight injured. The Syrian air force's final claim for victories was 21 Israeli aircraft and helicopters destroyed, although this probably includes unmanned aerial vehicles and target drones shot down.

25 The modes available were: Auto, where the pilot designated the target, aligned a vertical steering bar with the target in the HUD, held down the weapon release consent "pickle" button and waited for the computer to decide when to release the bombs; Continuously Displayed Impact Point, which let the pilot fly a reticle aiming dot in the HUD over the target and, at the moment the two coincided, press the pickle button to release the bombs immediately; Guided Weapon Mode, which offered IR and electro-optical (TV) imagery on the VSD from an appropriately equipped munition; and Direct and Manual back-up modes.

26 The F-15A/B/C/D would eventually be cleared to release a wide range of LDGP bombs as well as precision weapons such as the GBU-15 and AGM-65 Maverick.

27 In this instance, one GBU-15 malfunctioned on the aircraft and was not dropped, and a second missed the target. Despite having the target obscured by smoke and debris from the four hits, the two F-15Cs delivered their 12 Mk 82s with great accuracy. The raid killed a total of 73 people, 60 of them PLO terrorists, and injured another 70. The PLO compound, like the Iraqi reactor four years before, was left in total ruins.

28 Jenkins, p.53.

29 Other retired IAF F-15As include 73-0107 which became the gate guardian on display at Tel Nof AB and 72-0117 (which was AFDT&E F-15) which is now an instructional airframe at the IAF Technicall School at Haifa.

30 One has to wonder about the veracity of this claim by Israeli sources, not least of all because of the tender loving care these jets had received under the ownership of the doting Louisiana ANG.

31 Some sources state November.

32 AGM-145A Joint Stand-off Weapon (JSOW), and AGM-158 Joint Air-to-Surface Stand-off Weapon (JASSM).

33 Joint Direct Attack Munition – a guidance kit, internal measurement sensor and global satellite positioning receiver that is strapped to an LDGP bomb to make it "smart" and permit precision strike of a set of GPS coordinates in all weather, day or night.

34 33 victories were scored during Operation *Peace for Galilee* in the period June 5–12, 1982. Another 44 kills were claimed by IAF F-16s and one IAF F-4E was credited with shooting down one Syrian MiG.

35 Most individual IAF Eagles have a nickname, usually written on the side of the nose, well forward. The single-seat F-15A/Cs are given a one-word nickname and the two-seat F-15B/Ds have two-word (in Hebrew) nicknames.

36 *Peace Sun I* included F-15Cs 80-0062 through -0106 and 81-0002, and F-15Ds 80-0107 through -0121, and 81-0003. These aircraft differed from USAF models in the absence of ALQ-128 pods from atop the left vertical stabilizer and the ALQ-135 antennae beneath the nose.

37 *Peace Sun VI* included F-15Cs 90-0263 through -0271, and F-15Ds 90-0272 through -0274.

38 Some sources report that the second F-4E was only damaged and recovered to Iran.

39 See Davies, Steve, *F-15C Eagle Units in Combat*, Osprey Publishing, Oxford, UK, 2005, for detailed information.

40 The JASDF uses a rather complex serial number system where the first digit is the last digit in the calendar year of delivery (not of purchase, as is the USAF system). The second digit represents the class of aircraft (2 = multi-engined), third is the role of the aircraft (8 = all-weather fighter) and the last three digits are the serial number in sequence of manufacture, with the F-15 type beginning with 801 (79-0280; F-15DJs began numbering at 051). Thus the first indigenously assembled F-15J, 12-8803, was the third F-15J multi-engined, all-weather fighter and was produced in 1981.

41 SD e-mail interview with Maj Justin Fletcher, April 13, 2006. All quotes are taken from the same interview unless otherwise noted.

42 Including 10 sorties for contact phase (two initial contact, four instrument, four cross country), 17 formation (15 day and two night), 15 air-to-air training sorties (four offensive BFM, four defensive BFM, four high-aspect BFM, and three 2 v 1 canned (pre-defined) ACM), 18 intercept (12 day (broken into nine single ship and three 2 v 1 radar trail sorties) and six night (two single-ship and four 2 v 1 radar trail sorties)), 17 commander's selection sorties which could be any of the above sorties (as required), and two evaluation sorties (mid and final). The students also "fly" 23 sorties in the simulator.

43 A six-week USAF course that takes newly winged pilots and prepares them for the FTU by teaching them the basics of flying fighters as a combat wingman, using the Northrop T-38C Talon.

44 Japan operates the (V)0 radar with tapes CAH, CBL and CBM.

45 Japanese F-15J/DJs are equipped with a J/TEWS.

CHAPTER 10: IMPROVED EAGLES

1 Key aspects of the Eagle's avionics suite that required improvements were identified formally in the March 1982 *F-15/F-16 Super Program Assessment Review.*

2 Report by Hughes, John, *MSIP Spells "Success" for the F-15 Eagle*, January 24, 1997.

3 To all intents and purposes, MSIP F-15As received the same upgrades as MSIP F-15Cs. The biggest difference is that none of the A-models received the RWR ALR-56C (digital) modification, and all still have the ALR-56A (analog) system. Installing the hardware was not actually part of the MSIP modification, but putting in the wiring to support it was. It appears the A-models never got the wiring to support ALR-56C. For a long time one of the primary MSIP test jets at Eglin AFB was actually an F-15B (73-114). Virtually all of the C/D fleet was upgraded to MSIP and the authors were given one estimate of c.70 percent of A-models got the upgrade – the remainder (generally 1973 and 1974 jets) were retired or

turned into ground trainers because they were too old to warrant the expense of the MSIP modification. Most, but not all, A-models received ALE-45 CMDs – this was not actually part of the MSIP modification, although it was usually performed at the same time.

4 Unclassified USAF talking paper *MSIP Ceremony*, Maj Kevin Coleman, 339th FTS.

5 The onboard NCTR library was much later increased in size to accommodate 14 specific aircraft types.

6 Eglin's APG-70 jets went to RAF Lakenheath to establish the 493rd FS after their stint with the 33rd TFW.

7 Minus those lost to accidents in the intervening period.

8 The Eagle's INS is supplemented by the attitude heading reference set (AHRS), which provides magnetic heading information, and, if the INS fails, roll and pitch data. Some Eagles' AHRS have been replaced by an integrated GPS system (EGI) which is discussed in Chapter 14.

9 Suite 4M was being introduced to service in 2006, although there were no firm dates as to when the upgrade would be completed – aircraft were typically modified on a wing by wing basis.

CHAPTER 11: WHEN EAGLES FLY, MIGS DIE!

1 SD telephone interview with Col Larry Pitts, June 13, 2003. All Pitts quotes that follow are taken from the same interview unless otherwise noted.

2 SD telephone interview with Col Jay Denney, June 11, 2003. All Denney quotes are taken from the same interview unless otherwise noted.

3 Figures quoted are official USAF intelligence inventory estimates made at the time, since unclassified.

4 SD telephone interview with Col Jon Kelk, June 16, 2003. All Kelk quotes are taken from the same interview unless otherwise noted.

5 Recollections from Tollini and Kelk about who turned east and who turned west are conflicting.

6 SD telephone interview with Col Rick Tollini, USAF, Ret, June 18, 2003. All Tollini quotes are taken from the same interview unless otherwise noted.

7 In their eagerness to report the "first kill of the war," the USAF public affairs (PA) cell based at the relatively plush and comfortable Dhahran with the Central Command staff erroneously reported that Capt Steve Tate's (71st TFW) victory was the first of the campaign. It was not until later that the reports from the more remote and austere Tabuk came in showing Kelk's kill as the first. By then the PA folks had moved on to report more dramatic events, such as the results of the first day's bombing, never bothering to correct their initial misinformation.

8 Magill was flying the F-15 on a USMC/USAF exchange program.

9 SD telephone interview with LtCol Chuck Magill, July 22, 2003. All Magill quotes are taken from the same interview unless otherwise noted.

10 "Hot" and "cold" are terms used to describe a target's aspect relative to the launch aircraft. "Hot" targets fly towards it, "cold" targets fly away from it.

11 They had actually departed the area to provide cover in case the original MiG-29 group attempted to pincer the flight.

12 The AIM-7 was somewhat problematic throughout the war and Bitburg pilots in particular experienced a large number of malfunctioning AIM-7s.

13 SD telephone interview with Col Cesar Rodriguez, June 24, 2003. All Rodriguez quotes are taken from the same interview unless otherwise noted.

14 Drendel, Lou, *...And Kill MiGs*, Squadron Signal Publications, Texas, 1992, p.101.

15 The imaginary line that extends from the left wing to the right wing; from 3 o'clock to 9 o'clock.

16 SD telephone interview with LtCol Tony Schiavi, June 24, 2003. All Schiavi quotes are taken from the same interview unless otherwise noted.

17 Rodriguez recalls that the AWACS was not initially sure if the target was a single MiG or a car travelling at high speed.

18 SD telephone interview with Col Thomas Dietz, June 13, 2003. All Dietz quotes come from the same interview unless otherwise noted.

19 USN F-14 destroyed one helicopter, USAF A-10 destroyed one helicopter, USAF F-15E destroyed one helicopter (with a bomb!) and USN F/A-18s destroyed two MiG-21s with AIM-7/9.

20 Another 137 IRAF aircraft were flown into Iran, where they were interned.

CHAPTER 12: BURNING DEAD DINOSAURS: ENFORCING THE NO-FLY ZONES OVER IRAQ

1 In one of the many sweeping (and largely unnecessary and disruptive) changes made by CSAF Gen Merrill "Tony" McPeak in the early 1990s, all training units were gathered under Air Education and Training Command (AETC, usually referred to as "Air Etc" by fighter pilots) and in doing so the traditional and revered Replacement Training Unit gave place to the more generic Flying Training Unit.

2 A similar fate befell the 50th FW at Hahn AB, although that base became a rather thriving regional airport for the Hunsrück area of Germany. At the same time, Ramstein's two F-16 squadrons (the 512th and 526th) were relocated to Aviano AB, Italy, to become the 510th and 555th FSs respectively, the latter of which was the famous former F-15 RTU. These changes left the 52nd FW at Spangdahlem as USAFE's only fighter base in Germany.

3 The raid was made up of equal numbers of F-111s and crews from each of the four squadrons (at that time) of the 48th TFW. Being the most senior, the 493rd TFS commander led the raid and his pilots and WSOs crewed six of the 24 jets participating in the raid.

4 Additionally the 58th FS sent its APG-63(V)1/(V)2/-220 engine MSIP-Cs to Elmendorf and the 60th FS APG-70/-220 jets went to Mountain Home AFB, Montana, to equip the new 390th FS. The latter was part of the 366th Wing, a composite organization (another of McPeak's initiatives) that placed all the best things about American air power together in one unit, but were in packets too small to use them with effectiveness. As stated elsewhere, the 33rd "Nomads" was re-stocked with older, less powerful MSIP-Cs from drawdowns elsewhere in the force.

5 In fact COUGAR was reportedly receiving the IFF returns from EAGLE flight's IFF transponders; it was not actually detecting them via direct radar returns. A minute later the IFF returns from the UH-60 were not only clearly visible, but were also identifiable as being in the same location as TIGER 01's reported contacts, yet AWACS still did not inform the TIGER flight of the presence of IFF data in the target area. This made the AWACS controller culpable in the follow-on investigation to this immense tragedy.

6 Since just after the end of ODS, the F-16 had been getting all the kills. An F-16D shot down an Iraqi MiG-25 in OSW in December 1992 and an F-16C shot down an IRAF MiG-23 in OPC the following month. Just over a year later, and only six weeks prior to this incident, two F-16s had destroyed four Serbian G-4 Super Galebs in Bosnia. Fueled by the intensely strong rivalry between the Viper and Eagle communities, this led to a feeling of "it's our turn next; when the opportunity arrives, be ready" within the squadron. Psychologically, this attitude resulted in a predisposition to shoot first rather than the more common conservative and cautious approach taken by most F-15 units both before and after this tragic event. The squadron commander, by definition, is responsible for the attitude within his squadron.

7 While the flight lead is in charge of the mission, the supervisory duties of a squadron commander never end. To say that: "I was only the wingman" is tantamount to the

Nuremburg defense of: "I was only following orders." The squadron commander is responsible for the results of every mission his unit flies, even the ones he participates in, even if he is not the leader of his flight. The commander was not a reluctant participant in the tragedy, but instead – as indicated by his enthusiastic and tasteless victory cry terminating the engagement – a very willing one.

8 Actually the flight leader, after being charged, was given immunity by the USAF Staff Judge Advocate's (JAG) office prosecuting the case, in exchange for testifying against his squadron commander/wingman. Even with his testimony as part of the JAG's case, the commanding general dismissed the charges on the squadron commander for "lack of evidence."

9 The MIM-23B Improved-Hawk (Homing All the Way Killer) missiles in the Iraqi inventory were former Kuwaiti I-Hawk missile batteries captured by the Iraqis in their 1990 invasion of Kuwait.

CHAPTER 13: BALKAN KILLS

1 SD telephone interview with Col Cesar Rodriguez, July 30, 2003. All subsequent quotations are taken from the same interview unless otherwise noted.

2 This entire account is used with kind permission of Craig "Quizmo" Brown and comes from his book, *Debrief: A Complete History of US Air-to-Air Engagements, 1981 to Present*, Schiffer Publishing.

3 The following account is constructed from an e-mail widely reported to have been written by Hwang.

CHAPTER 14: THE EAGLE'S FUTURE

1 Essentially the (V)2 is a set APG-63(V)1 LRUs behind the "firewall," with an active electronically scanned phased array radar in front of it. Reportedly it was mounted in the F-15 as an operational test of the concept being developed for the F-22's APG-77 AESA. It is so powerful it requires the complete capacity of one of the aircraft's engine-mounted generators to run it and consequently it can see out to practically the full limits of the display scope.

2 SD interview with Dick Banholzer, Boeing HQ, St. Louis, June 2006.

3 The original wiring for air-to-ground weapons was removed from the USAF's jets.

4 Tirpak, John A., "Making the Best of the Fighter Force", *Air Force Magazine*, Vol.90, no.3, March 2007, pp.40, 44.

APPENDICES

1 F-15A 71-0289 (the pre-production Cat I CDT&E test jet F-10) is the oldest active Eagle in the USAF inventory.

2 It is believed that either Magill or Underhill shot down the MiG-29 flown by IRAF Col Walid, a former MiG-21 and F1EQ pilot. He ejected safely and was shepherded to Saudi Arabia by bedouin who had witnessed the engagement. There he sought, and was granted, political asylum.

3 According to the USAF Historical Research Agency the identity of this helicopter differs from one report to another.

4 This airframe was subsequently lost in 2001 following a fatal crash over Scotland.

5 All of the IAF's kills with Eagles have been scored against the Syrian air force.

6 Basic weight, plus pilot and unusable fuel.

7 Maj Roger Smith, Maj W. R. MacFarlane and Maj Dave Peterson of the Joint Test Force, Edwards Air Force Base.

8 72-0119 was actually an attrition aircraft, and was not being used on the test program.

9 Later to become known as NF-15B ACTIVE.

10 Made from modified F/A-18 horizontal stabilizers.

Index

References to illustrations are shown in bold.

A

ACEVAL (Air Combat Evaluation) tests 25, 51, 66–71
    innovations 70–71
Addams Family, The 87
Advanced Fighter Technology Integration (AFTI) program 254
Advanced Turbine Engine Gas Generator (ATEGG) 15, 31
    see also motors
Aerospatiale SA342L Gazelle 147
AFPEs (Air Force Preliminary Evaluations) 42, 43
AFTI (Advanced Fighter Technology Integration) program 254
AIMVAL (Air Intercept Missile Evaluation) tests 25, 51, 66–71, **67**
    innovations 70–71
Air Force Preliminary Evaluations (AFPEs) 42, 43
Air Policing 96
Air Tasking Order (ATO) 175, 176, 203, 204
air-to-air vs air-to-ground 35
air-to-ground capability 148–149
Airbus A300 **154**
Airscoop (Feb. 1969 edition) 20, 21
Al-Shamrani, Saleh 247
Al Taqqaddum Air Base, Iraq 184, 187
Alaska, flying in 120–122
Ålborg, Denmark 102
Allied Air Forces Central Europe (AAFCE) 96
Allied Tactical Air Force, 2nd (2ATAF) 96, 104
Allied Tactical Air Force, 4th (4ATAF) 96, 98
Anderegg, Col Dick 66
Arriola, Lt Mark 184, 185–186, 195
Aspin, Les 42
ATEGG (Advanced Turbine Engine Gas Generator) 15, 31
    see also motors
ATO (Air Tasking Order) 175, 176, 203, 204
Ault, Cmdr Frank 28–29

B

Bay 5 33
Beals, LtCol Matt "Boz" 87, 132–133
Beech C-12F/J 120
Beesley, "Magic" 87
Bekaa Valley 146, 147
Bell, "Taco" 87
Bellis, LtGen Benjamin N. 21, 24, 42, 43, 44, 103, 253
Ben-Eliyahu, LtCol Eitan 144, 248
Ben-Zur, Yuval 248
Bergman, LtCol Art 49
Biggum, Randy "Bigs" 200
"BillyMac" 218, 222
Bodø, Norway **95**
Boeing 12, 230, 252, 257
    see also McDonnell Douglas
    707 tanker 149
    B-52 Stratofortress 11, 60, 125
    CQM-99B BOMARC **50**, 51
    E-3 AWACS 96, 104, **151**, 203–204
    E-3A AWACS 128
    E-3B AWACS 120
    KC-135 Stratotanker 43, 62, 95, 122, 128, 180, **205**, **237**
    RC-135 Rivet Joint 193, 196
Bohn, Jr., LtCol John W. 11–12
Bong, Maj Richard I. 102
Bosworth, Brian 87
Boyd, Maj John R. 12–13, 15, 17, 20, 69, 82
BRAC 2005 141, **234**, 235
Britain, Battle of (1940) **116**
British Aerospace Harrier 206
    Harrier GR.Mk 3: 89–90
Brooks, Lt Robert 180, 181, 182–183
Broome, Lynn "Boo Boo" 200
Brown, Dr. Harold 15, 20
Bulge, Battle of the (1944) 93
Burns, Col John J. 17, 19
Burrows, Irving L. 37, 38–40, **39**, 43, 253
Bush, Sr., President George 171, 175
Bush, Jr., President George W. 213

C

cabling 24
callsigns, tactical 86–87
Campbell, Col Frank "Ted" 102
CAOC (Combined Air Operations Center) 203, 204, 222
CAS (control augmentation system) 40, 76–78
CFTs (Conformal Fuel Tanks) 114–115, 128, 145, **148**, 149, 151, 256
checks, pre-flight 74–78
Childress, BrigGen 257
China Lake Naval Weapons Test Center, California 51
Clark, Denver 131
Clashes: Air Combat over North Vietnam 1965–1972 10
climb, zoom **106**
CMD (Countermeasures Dispenser), ALE-40/45 **32**, 32, 33, **132**
cockpit checks 75–78
cockpit design 29
cockpit procedures trainer (CPT) 80
cockpits
    F-15A **77**
    F-15C MSIP **163**
    F-15J **156**
Cohen, Michael 248
Combat Training, Dissimilar Air (DACT) 51, 62, 64–65, 83, 87–91, **90**
Combined Air Operations Center (CAOC) 203, 204, 222
computer, central (CC)
    CP-1075 24–25, 28, 115
        overload warning system (OWS) 115, 116–117
        testing 46–47
    VHSIC 151, 162, 163
Constant Peg program 91
construction planning 23–24
control augmentation system (CAS) 40, 76–78
control stick **30**
    see also Hands On Throttle And Stick
control stick, MSIP 163

Convair F-102 Delta Dagger 11, 17, 60, 122, 126
  F-102A 94, 103
Convair F-106 Delta Dart 7–8, 9, 17, 51, 119, 122, 123, 126
  F-106A 60
Countermeasures Dispenser (CMD), ALE-40/45 **32**, 32, 33, 132
Countermeasures Set, Internal (ICS), ALQ-135 32, 33, 34, 35
  ALQ-135B 159, 163
Cox, "Vegas" 87
CPT (cockpit procedures trainer) 80
Craft, LtCol Richard L. 62
Crested Cap concept 102
Crested Eagle deployments 102
Croatia 215
Cubic Corporation ACMI range 66–69, 71
Curtiss JN-4 "Jenny" 135
Curtiss P-40 Warhawk 102, 107–108, 112

D

DACT (Dissimilar Air Combat Training) 51, 62, 64–65, 83, 87–91, **90**
Dassault
  Mirage F1C 88–89
  Mirage F1CR 206
  Mirage F1EQ 151, 174–175, 180, 182, 183, 184, 199, 247
data link, Joint Tactical Information Distribution System (JTIDS) 162, 167–168
data transfer module (DTM) 162–163, 167
Dayton Peace Accords (1995) 217
DCA (defensive counter air) missions 175
DeBellevue, Capt Charles B. 53
Delilah SAM decoy drone 146
deMilliano, Maj Steve "Two Dogs" 166
Denim, "Wild Bill" 217
Denney, Capt Jay "OP/Opie" 87, 172, 198–199, **199**, 246
description, pilot's 73–78
design 23–24
designers, fighter 7
Development Concept Paper (DCP) 20
Dietz, Capt Thomas "Vegas" 199, 200, 201, 201–202, 246
Dildy, LtCol Doug "Disco" 64, 65, 73, 87, 98–99, 162, **205**, 205, 250
Dingey, Capt Steven 246
Disosway, Gen Gabriel P. 19
Dissimilar Air Combat Training (DACT) 51, 62, 64–65, 83, 87–91, **90**
Dobronski, Joe 23, 38
Doneski, Capt John 246
Doppler, Christian A. 15
Douglas WB-66 Destroyer 46
Draeger, Capt Rhory "Hoser" **184**, 184, 185–186, 195–196, 198, 246, 251
Driggers, "Dirk" 218
drone, Delilah SAM decoy 146
drones, BOMARC 50, 51
DTM (data transfer module) 162–163, **167**

E

"Eagle Eye" VID device 70
Eagle name selected 53, 253
Eddins, Col Neill 103
EEC (Electronic Engine Control) 47
EGI (Embedded GPS/INS) 230, 231
ejection 64–65, 135
Electronic Warning Warfare Set (EWWS), AN/ALQ-128 33
Eleven Days of Christmas 11
Energy-Maneuverability Theory 12–13, 17, 82
Energy Maneuvering (EM) graph 13–14
Engine Control, Electronic (EEC) 47
engineering change proposals (ECPs) 42–43, 49
engines *see* motors
England, RAF Lakenheath **203**, 208, **226**, 237, **247**
English Electric Lightning F.Mk 52/53 151
Eshel, Capt Shai 144
Etain, France 102
EW pod, fictitious 129
EWWS (Electronic Warning Warfare Set), AN/ALQ-128 33
exercises
  Cooperative Cope Thunder 156
  Red Flag 11, 63, 78, 90, 91, 95, 135, 176, 235
  Red Flag North 122
exterior inspection, pilot's 74

F

F-15 designation adopted 20, 252
F-15 program as political football 42–43
"F-X" program 252
  concept 12, 37
  Concept Development Package (CDP) 14, 19, 20
  Concept Formulation Study (CFS) 12, 17, 18, 252
  design, developing 14–22
  design requirements 19
  design study 17, 18, 21
  McDonnell Douglas wins competition for 21, 252
  motors, turbofan 14–15
  radars, Doppler 15, 17, 26
  requests for proposal (RFP) 12, 14, 20, 21, 252
  single-seat, decision for 17
  Technical Development Plan (TDP) 14
Fairchild Hiller 18, 20, 21
Fairchild-Republic 252
Feldsho, Yoel 144, 248
Fighter Data Link (FDL) 132, 229–230
  "SIT" display **230**
"Fighter Mafia" 20
fighters, Century-series (F-100 through F-106) 7–8
Fisher, Capt Mike "Fish" 195
Flanagan, LtCol Mike "Father" 137
flaps 76, 79
Fletcher, Maj Justin "Ringo" 154–156, 157
flight control linkages 76
flight control system 40
flight simulators 39, **261**
flying the F-15 80–84
Focke-Wulf Fw 190: 7
Fogleman, Gen Ron 211
Fontaine, Capt 135
Force Options for Tactical Air 11–12
Ford, President Gerald R. 53
Fort Monroe, Virginia 59
Frasier, "Skeet" 87
fratricide 208, 209–211
fuel tank imbalance 82–83
Fuel Tanks, Conformal (CFTs) 114–115, 128, 145, 148, 149, 151, 256
Fuji T-3 154

G

g-forces 57
"geasies" 83
general arrangement diagram 21
General Dynamics 18, 252
  F-16 Fighting Falcon 126, 164, 184, 192, 205, 206, 207, 215, **237**, 256
  F-16 *Netz* (Hawk) 145, 147
  F-16A 143
  F-16ADF 126, 134
  F-16CJ 203, 204, 207, 218, 219, 222
  F-111 Aardvark 8, 9, 11, 18, 47, 206
  F-111F 208, 226
General Electric 15

Germany
Bitburg AB 84, 86, 93, 96, 102, 111, 206, 207, 237, 254
Roether Memorial Zulu Alert Facility **94**, 96, 98
see also "Zulu Alert"
Spangdahlem AB 102, 206–207, **207**, 238
GIUK (Greenland-Iceland-UK) Gap 126–129
Goben, Capt Omar 180
God Is My Co-pilot 93
Goldfein, LtCol Dave 217
GPS/INS, Embedded (EGI) 230, 231
Graeter, Capt Robert "Cheese" 87, 178, 180–183, 185, 227, 246
Graff, George 39
Granrud, LtCol Garth 122–124, 167
Green, Sgt Donald 218
Greenland-Iceland-UK (GIUK) Gap 126–129
Ground Hog Day 211
Grumman 18, 252
see also Northrop Grumman
C-1 Trader **97**
E-2C Hawkeye 144, 147
EA-6B Prowler 218
F-14 Tomcat 8, 69, 71, 151, 192, 193
F-14A 31, 51, 87–88, 143
Gulf War (1991) **55**, 70
see also Operation *Desert Storm*
Guttman, Capt Nick 212

H

"Hammer" 100–101
Hampel, Oran 248
Hampton, Virginia 61
Hands On Throttle And Stick (HOTAS) 29–31
see also control stick
Hawaii **131**, 133, 238
heads up display (HUD) 24, **26**, **27**, 28, 70, 81
Heibemann, Lt Bob "Gigs" 87, 199, 200, **201**, 201–202, 246, **247**
helmet, HGU-36 **100**
helmet, HGU-55 **94**
Helmet, Lightweight (LWH) 71
Helmet Mounted Cueing System, Joint (JHMCS) 71, 229, **233**
Henry, Pat 40
Hickey, Jr., Herbert J. 254
High Jump Project 9
Hodorov, Amir 248
Hofman, Yoram 248
Homsher, Paul 21
horizontal situation indicator (HSI) 24
HOTAS (Hands On Throttle And Stick) 29–31
see also control stick
Howard, Ron 87
Hruska, Joe "Corn" 64–65, 87
HSI (horizontal situation indicator) 24
HUD (heads up display) 24, **26**, **27**, 28, 70, 81
Hughes Aircraft Company 17, 26, 165, 253
Missile Systems Group 159
Hussein, Saddam 171, 174, 189, 203, 213
HVACAP missions 175
Hwang, Capt Jeff 215, 223–224, **224**, 227, 246

I

IAI Kfir C2 144, 146
Iceland 127, 213
Keflavik NAS 127, 128, 129, 238
ICS (Internal Countermeasures Set), ALQ-135 32, 33, 34, 35
ALQ-135B 159, 163
Improvement Program, Multi-Stage (MSIP)
see Multi-Stage Improvement Program
INS (inertial navigation system) 76, 165, 167
see also GPS/INS, Embedded
inspection, pilot's exterior 74
instructor pilots (IPs) 56, 58, 62
first assignment (FAIPs) 58
instrument panel, F-15A 77
Iran 143
Iran-Iraq War (1980–88) 174
Iranian air force 88, 151
Iraq 171
see also Gulf War; Operation *Desert Storm*
Al Taqqaddum Air Base 184, 187
Osirak/Tammuz nuclear reactor complex strike 145, 256
Iraqi air force (*Al Quwwat al Jawwiya al Iraqiya*) 89, 174–175, 187, 196, 201, 203, 204, 205, 213
Air Defense Command 174, 175
Air Support Command 174–175
Aviation Corps 174
Training Command 174
Transport Command 174
Israel 146
Israeli Defense Force/Air Force (IDF/AF - Heyl Ha'Avir) 143–151, **145**, **148**, 229, 239, 244, 248, 254, 257
8 *Bacha* (wing) 239
106 *Tayeset* (squadron) 145, 239, 244
133 *Tayeset* 143, 144, 239, 244
138 *Tayeset* 149
148 *Tayeset* 239
F-15 kills 248
F-15 mishaps **244**, 244
Italy, Aviano AB 215

J

Jacobsen, LtCol David "Jake" 66, 240
Japan, Kadena AB **97**, 111, 114, 138, 156, 237, 254
Japan Air Self Defense Force (JASDF - *Nihon Koku Jietai*) **143**, 152–157, 239
2nd *Koku-dan* **154**, 239
5th/6th/7th/8th *Koku-dan* 239
23rd Flying Training Squadron 154–155, 239
201 *Hiko-tai* 152, 239
202 *Hiko-tai* 152
203 *Hiko-tai* 152, 153, 239
204 *Hiko-tai* 152, 239
303 *Hiko-tai* 152, 239
304 *Hiko-tai* 239
305 *Hiko-tai* 239
306 *Hiko-tai* 239
F-15 mishaps 245
Hiko Kyodo-tai (Aggressor Squadron) **155**, 157, 239
Jennings, Gary 34–35
JHMCS (Joint Helmet Mounted Cueing System) 71, 229, **233**
Johnson, President Lyndon B. 10
Joint Engine Project Office (JEPO) 31, 45–46
Joint Helmet Mounted Cueing System (JHMCS) 71, 229, **233**
Joint Test Force (JTF) 37, 48
JTIDS (Joint Tactical Information Distribution System) data link 162, 167–168
July, Fourth of (1989) 103–107

K

Kawasaki T-4 154
Keating, Tristan J. 254
Kelk, Col Jon "JB" 176, 177–180, 189, 191, 246
Kendel, Capt Rich "Hub" 66, 241
Kennedy Administration 8
Kennel, "Dog" 222
Khadafi, Omar 208
kills, F-15
IAF 248
RSAF 247
USAF 246
Kline, LtCol Tim "Sweet Lou" 128–129
Knaani, No'am 248
Knights, Jack 40
Korean Airlines flight KAL007 152

- Korean War 7, 9, 102, 112
- Kosovo 217, 218
- Kremble, LtCol Dennis G. 203
- Kuwait 171
- Kyler, BrigGen Fred 94, 95

L

- Lapidot, Offer 248
- Lebanese Civil War 146
- Lebanon 146
- Lev, Miki 248
- Lewis, "Rowdy" 87
- Lipsitz, Zvi 248
- Little, Bob 39
- Locher, Capt Roger C. 53
- Lockheed 12, 18, 252
  - A-12 series 12
  - C-5 Galaxy 37, 47
  - C-130 Hercules 205
  - C-130H 120
  - F-80 Shooting Star 102
  - F-94 Starfire 17, 60, 122
  - F-94A 126
  - F-104J Starfighter 115, 152
  - F-117 "Stealth Fighter" 177, 178, 215, 218, 219–220
  - F-117A 102
  - P-38 Lightning 7, 60, 112
  - P-80 Shooting Star 93
  - T-33A Shooting Star 115, 126
  - U-2R 204
- Lockheed Martin
  - F-16 *see* General Dynamics F-16
  - F-22 Raptor **131**, 133, 134, 141
  - F-22A **229**, **234**, 234, 235
  - F-35 Lightning II **234**, 234, 235
- Lodge, Maj Robert A. 53
- *Lone Ranger* 87
- "Look/Shoot Lights" 70–71
- Loral ALR-56A radar warning receiver (RWR) 32, 33, 34, 35, 163
- Lucas, LtCol Jon I. 103
- Luke, Lt Frank 60

M

- Madden, Capt John A. 53
- Magill, Capt Chuck "Sly" **183**, 183, 184–187, 195, 226–227, 246
- maiden flight 37, 38–39, 253
- Malvern, Donald 21, 25
- maneuvers, high-*g* 83
- Maor, Avi 248
- Margalit, Ilan 248
- Martin, Capt J. D. "JD" 103, 105–106, 107
- Masters, Capt Gregory 246
- material distribution and use **24**, 24
- Mathis, MajGen Robert C. 254
- Maw, Lt Scott 180, 181, 182, 183
- May, Maj Randy 246
- McConnell, Gen John P. 12, 19–20
- McDonnell, James S. "Sandy" 21, 37, 39
- McDonnell Douglas Aircraft Company division (McAir) 17, 23
  - A-4 Skyhawk 144, 146
  - design team 14
  - F-4 Phantom II 8–9, 10, 11, **18**, 20, 23–24, **25**, 29, 39, 81, 144
    - radar **13**
  - F-4B 8, 9
  - F-4C 9, 10
  - F-4D 10–11, **12**, 93, 102, 114, 135, 208
  - F-4E 7, 19, 38, 53, 62, 96, 103, 108, 119, 146, 147, 151
  - F-4EJ 152
  - F-4G 192, 203, 204
  - F4H-1 9
  - F-4J **115**
  - F-15 Agile Eagle S/MTD (NF-15B) 257, 259, 261, **262**
  - F-15 *Baz Meshopar* (Improved Falcon) upgrade 149, **150**
  - F-15 (Model 199-B) Eagle
    - final stage development contract awarded 20–21, 252, 253
    - *Gulf Spirit* **179**
  - F-15 Streak Eagle (72-0119) 259
  - F-15A 51, 102, 115, 116, 226, 249
    - 73-0109 253
    - 74-0099 **120**
    - 74-0103 126
    - 74-0105 **120**
    - 74-0128 132
    - 74-0129 66
    - 75-0040 **139**
    - 75-0042 66
    - 75-0049 94, **100**
    - 75-0059 110, 111
    - 75-0060 **254**
    - 76-0030 137
    - 76-0058 134
    - 76-0063 **73**
    - 76-0071 **61**
    - 76-0076 **61**
    - 76-0078 **80**
    - 76-0117 **123**
    - 76-0118 **123**
    - 76-1518 **145**
    - 77-0074 **127**
    - 77-0077 **127**
    - 77-0082 **23**
    - 77-0084 124
    - 77-0091 **23**
    - 77-0092 **63**
    - 77-0100 **250**
    - 77-0114 **127**
    - 77-0117 **74**, **106**
    - 77-0118 **213**
    - 1st TFW **59**
    - 18th TFW **97**
    - 32nd FS **205**
    - 43rd TFS 119, 119
    - 158th FS **140**
    - 405th TTW **73**
    - 555th TFTS **56**
    - Fighter Weapons School 112
    - Louisiana ANG **161**
    - Massachusetts ANG 138
  - F-15A *Baz* (Falcon) 143, 144, 145, 147, 148–149
    - No. 672 144
    - No. 686 151
    - No. 689 144, **145**
  - F-15A MSIP 102–103, 134, 161, 206
    - Louisiana ANG **133**
  - F-15A-1-MC **39**
    - 71-0280 (prototype) 37–40, 38, 39, 41, 49, 253
    - 71-0281 40, 41, 261
  - F-15A-2-MC
    - 71-0282 41
    - 71-0283 41
    - 71-0284 41, **45**
  - F-15A-3-MC
    - 71-0285 41
    - 71-0286 40, 41, **44**
  - F-15A-4-MC
    - 71-0287 41, **43**, 261
    - 71-0288 41
    - 71-0289 41
  - F-15B (formerly TF-15A) 33, 51, 58, 249, 253
    - 71-0290 40, 41, 256
    - 71-0291 41, 253–254, 256
    - 73-0108 53, 253
    - 74-0141 261
    - 75-0050 94
    - 76-0087 122

    76-0089 53
    76-0125 134
    76-0126 112
    76-0130 57
    76-0139 134
    77-0156 108
    77-0168 108
F-15B *Baz* (Falcon) 148–149
    No. 455 148
    No. 704 144
F-15B MSIP 161
F-15C 104, 111, 114–117, 119, 152, 171, 204,
    215, 226, 249, 250–251, 254
    see also Operation *Desert Storm*
    78-0470 111
    78-0500 114
    78-0505 125
    78-0527 115
    78-0543 114
    79-0022 172
    79-0027 93
    79-0058 197
    79-0073 95
    80-0004 209
    80-0005 231
    80-0019 94
    80-0074 151-152
    80-0129 151
    81-0023 137
    81-0040 67, 68
    81-0049 106
    84-0001 162
    84-0010 **34**, 229
    84-0014 176
    84-0015 247
    84-0027 247
    85-0102 194
    85-0119 251
    86-0161 252
    12th TFS 55
    32nd TFS 93
    33rd TFW 185
    58th FS 109
    67th FS 208
    493rd FS 116
    Missouri ANG 132
F-15C *Akev* (Buzzard) 145, 149, 150
    No. 840 151
F-15C *Peace Sun* 131, 152, **153**
    No. 514 151–152
F-15C MSIP **89**, 119, 162, 206, 207, 208, 226
F-15D 152, 171, 249, 251, 254, 257
    80-0060 121
    82-0046 173
    84-0002 162
  F-15D *Akev* (Buzzard) 145, 149, 150
  F-15D MSIP 162
  F-15D *Peace Sun* 151
  F-15DJ 152, 153–154, **155**, 155, 157, 249
  F-15E Strike Eagle 41, 120, 165, 177, 178, 181,
    183, 187, 204, 208, **226**, 230, **231**, 256
  F-15I Strike Eagle 149
  F-15J **115**, **143**, 152, 153–154, **154**, 155, 156, 157,
    249, 256
    12-8803 152
  "F-X" program *see* "F-X" program
  NF-15B (F-15 Agile Eagle S/MTD) 257, 259, 261, **262**
  RF-4E Phantom II 144–145
  St. Louis plant 37, **38**, **39**, 109, 119, 137, 152, 165,
    249, 253
    Building 1: 20
  Systems Project Office slogan **34**, 35
  TF-15A (later F-15B) 33, 51, 58
    76–0130 57
  TF-15A-3-MC 71-0290 40, 41, 256
  TF-15A-4-MC 71-0291 41, 253–254, 256
  TF-15A-7-MC 73-0108 53, 253
McDonnell Douglas F-15 Eagle 31
McDonnell Douglas/Mitsubishi Heavy Industries
  F-15DJ 152, 153–154, **155**, 155, 157, 249
  F-15J 152, 153–154, **154**, 155, 156, 157, 249
McDonnell Douglas's Product Support Digest 39–40
McKenzie, Capt Mark 246
McMullen, LtGen Thomas H. 256
McMurray, "Boomer" 223, 224
McNamara, Robert S. 8, 9
McPeak, Gen Merrill A. "Tony" 119
Melnik, Maj Moshe 144, 248
Messerschmitt Bf 109/110 7
Michel III, Col Marshal L. 10, 11
midair collisions 64–65, 66 *see also* mishaps
Mikoyan Gurevich
  MiG-15 "Fagot" 7, 8
  MiG-17 "Fresco" 8, 9, 10, 11, 53
  MiG-19 "Farmer" 8, 9, 11
  MiG-21 "Fishbed" 8, 9, 10, 11, 20, 53, 56, 91,
    144, 147, 151, 175, 217, 254
  MiG-21bis 147, 151
  MiG-23 "Flogger" 88, 89, 91, 95, 147, **172**, 184, 195,
    196, 197–198, 199, 247
  MiG-23BK "Flogger" 174
  MiG-23BN "Flogger-F" 147, 174
  MiG-23M "Flogger-B" 103–104, 105–107
  MiG-23MF "Flogger-B" 147, 175
  MiG-23ML "Flogger" 175
  MiG-23MS "Flogger" 147, 174, 175
  MiG-25 "Foxbat" 12, 14, 14, 15, 51, 93, 144–145,
    147, 151
    in Operation *Desert Storm* **184**, **187**, **189**, 189–191,
  191, 199, 204
  MiG-25PD "Foxbat" 175
  MiG-25RB "Foxbat" 175
  MiG-29 "Fulcrum" 160, 160, 163, **174**, **233**, **251**
    in Operation *Desert Storm* 175, 180, 181, 184,
      186, **192**, **193**, 193–195, 212, 215, 217–218,
      222, **223**, **224**, 224
  MiG-31 "Foxhound" 160–161
Miller, Jethro **199**
Milosevic, President Slobodan 215
mishaps, F-15
  see also midair collisions
  Israeli Air Force **244**, 244
  Japan Air Self Defense Force 245
  Royal Saudi Air Force 245
  United States Air Force 240–243
missions
  defensive counter air (DCA) 175
  HVACAP 175
  offensive counter air (OCA) 121, 122, 175–176
Mitsubishi Heavy Industries Ltd 152, 249
  see also McDonnell
  Douglas/Mitsubishi Heavy Industries
  Zero 7
Mohr, LtCol Moss "MOS" 135
Momyer, Gen William W. "Spike" 37, 60, 61
motors, Pratt & Whitney 31–32
  air inlet system **31**
  F100-PW-100 (USAF) 31–32, 40, 46–47, 78, 79,
    253, 258
    afterburner 46–47, 58, 81
    problems 42, 47, 95, 108–109, **110**, **110–111**
    testing 43–44, 45–46
    "turkey feathers" **45**, 47
  F100-PW-220 **167**, 168–169, 258
  F100-PW-220E 137, 153, 258
  F401-PW-400 (USN) 31
  starting 75
Moulton, Capt Greg "Lava" 87, 120–122, **229**, **230**
Mount McKinley 120–121
Moylan, Capt Pat "Pat-O" 195
MSIP *see* Multi-Stage Improvement Program
multi-purpose color display (MPCD) 162, 167, 230
Multi-Stage Improvement Program (MSIP)
  71, 102–103, **159**, **161**, 161–163, **163**, 165,
  168, 169, **224**, 256, **258**
Muppets 97, 99

Murphy, Capt Anthony R. "ET" **194**, 246
Murphy, Capt Bill "Turf" 103, 105–106
Murray, Bill 211
MUX upgrade 162

N

Nadlvi, Ziv 248
"Nail" 100–101
NASA (National Aeronautics and Space Administration) 261–262
  Langley Research Center 14, 17
NATO (North Atlantic Treaty Organization) 127, 128, 205, 206, 215, 217, 227
  AWACS controllers 215, 218, 219, 220, 221–222, 223, 227
  Central Region integrated air defense system (IADS) 96, 97
Navch, Avner 248
navigation system, internal (INS), LN-94 76, 165, 167
NCTR (Non-Cooperative Target Recognition) 163, 169
Netherlands Air Force, Royal (KLu) 103
Netherlands, Soesterberg AB 103, 207, 237
New York 138
  World Trade Center attacks 139
Night Vision Goggles (NVGs) 132, 133, 134
Nixon, President Richard M. 11
NORAD 119, 122, 124, 134
North American Aviation 12, 18, 252
  B-45 Tornado 45, 46
  F 51 Mustang 112
  F-82F Twin Mustang 126
  F-86 Sabre 7, 8
  F-86D 60, 126
  F-86E 207–208
  F-86F 93, 103
  F-86L 60
  F-100 Super Sabre 9, 135, 208
  F-100C 10, 93, 102, 103
  P-51 Mustang 7
  XB-70 Valkyrie 12
North American Rockwell 20, 21, 252
Northrop
  ALQ-135 Internal Countermeasures Set (ICS) 32, 33, 34, 35
    ALQ-135B **159**, 163
  F-5 Freedom Fighter 11, **90**
  F-5E Tiger II 11, 51, 66, 67, **185**
  P-61 Black Widow 126
  T-38 Talon 11
Northrop Grumman
  see also Grumman
  B-2 217, 218, 223
NVGs (Night Vision Goggles) 132, 133, 134

O

Oberg, Maj Tom **104**
Offensive Counter Air (OCA) missions 121, **122**, 175–176
OFP (operational flight program) 168
Olds, Col Robin 10, 53
Omar Goben, Capt 180
Omar Khadafi 208
Operation
  Allied Force 163, 208, 215, 217–224, 226, 227
  Bolo 10, 53
  Coronet Sandpiper 103
  Deliberate Force 208, 215
  Deny Flight 215
  Desert Shield **171**, 171–173
  Desert Storm 151–152, **153**, 163, 171, **172**, **173**, 175–176, **177**, **178**, **179**, **181**, **182**, **185**, 204, 208, 226–227
    see also Gulf War
    Air Tasking Order (the "frag") 175, 176, 203, 204
    day one (January 17, 1991) 176–187
    day three 187, 189–195
    day ten 195–198
    day eleven 198–199
    day thirteen 199
    day twenty one 199–201
    day twenty two 201
    summary 201
  Drugstore 146–147
  Eldorado Canyon 208
  Highspeed 9
  Linebacker I 9, 11, 53, 54, 56, 108
  Linebacker II 9, 11, 53, 54, 56
  Noble Anvil 215, 217–224
  Noble Eagle 122, **138**, 138–141
  Northern Watch 203, 205–206, 211–212, 213, 215, **250**
  Opera 145
  Provide Comfort 205, 209–211, 213
  Rolling Thunder 11
  Southern Watch 203–205, 211–212, 213, **213**
  Torch 108, 126
operational F-15, first 61, 62, 253
operational flight program (OFP) 168
Operational Test and Evaluation, Follow-on (FOT&E) 49, 50–51
Operational Test and Evaluation, Initial (IOT&E) 49–50
Operational Test Force (OTF) 49–50, 51
Orange, France 88
Osirak/Tammuz nuclear reactor complex strike 145, 256

P

Pacer Century program 253
Paled, Gen Beni 143
Palestine Liberation Organization (PLO) 144, 146
Parsons, Col Rick **194**, 246
Patz, Offer 248
Peace Eagle program 152–157
Peace Fox program 143–145, 148–151, 254
Peace Fox II program 143
Peace Fox III program 145
Peace Fox IV program 149
Peace Fox V program 149
Peace Sun program 151–152, 256
Peled, Yoram 144, 248
Pentagon 42
Philco-Ford 47
Pilot Training, Undergraduate (UPT) 58
pilot's description of F-15 73–78
pilot's exterior inspection 74
pilots, instructor (IPs) 56, 58, 62
  first assignment (FAIPs) 58
pilots, new Eagle (Initial Cadre) 56–59
  Class 76 BCL 59
  Class 76-11 58
pilots, test 37, 48
pilots' nicknames ("tactical callsigns") 86–87
Pitts, Col Larry "Cherry" 87, 171–172, 177, 178, 178, 179, 187, 187, 189–191, 191, 246
Playboy 129
PLO (Palestine Liberation Organization) 144, 146
Posigate, Maj Jim 70
Powell, Ben "Coma" 198, 199, **199**, 246, **247**
Prather, Capt David S. 246
Pratt & Whitney 15, 31, 44–45, 46, 47, 253
  see also motors
  TF30 engine 15, 108
pre-flight checks 74–78
production 249
  F-15A 249
  F-15B 249
  F-15C 249, 250–251
  F-15D 249, 251
  F-15DJ 249
  F-15J 249

production model, first 53, 253
Project *High Jump* 9
Project *Ready Eagle* 63, 93–96
Project *Sageburner* 9
Project *Skyburner* 9
prototype (71-0281) 37–40, 38, 39, 41, 49, 253
Pruden, Jr., Col Albert L 103

Q

Quick Reaction Alert (Interceptor) *see* "Zulu Alert"

R

Rachmilevitz, Yair 248
radar, AN/APG-63 26–29, 42, 51, 115, 123–124, 149, 227, 262
  acquisition modes 26, 28–29
  scope 25, 178
  special modes 29
radar, APG-63(V)2 AESA 119–120, 229–230, 233, 251, 257
radar, APG-63(V)3 AESA 230, 233
radar, APG-70 164, 164–165
radar, Phantom II 13, 26
radar control panel (RCP) 79–80
radar data processor (RDP) 26–27
radar warning receiver (RWR)
  ALR-56A 32, 33, 34, 35, 163
  ALR-56C 163
radars, Doppler 15–17
radio, F-15C 117
Rall, Jr., Fred T. 254
Randolph, "Log" 87
Rapaport, Gil 248
Raytheon 82
RCP (radar control panel) 79–80
RDP (radar data processor) 26–27
Ready Eagle program 63, 93–96
Ready Eagle III program 111–112
Ready Holloman program 102
Renner, Robert "Cricket" 217, 218
Republic
  F-84 Thunderjet 102, 122
  F-84E 93
  F-84F 207–208
  F-105 Thunderchief 7–8, 9, 10, 11, 114
  F-105D 93, 102
  P-47 Thunderbolt 7, 93, 207
Response Options (ROs) 204
review, BRAC 2005 141, 234, 235
Rhoades, "Dusty" 87
Richie, Capt Robert "Steve" 53
Rickenbacker, Capt Eddie V. 60
Rodriguez, LtCol Cesar "Rico" 192–195, 193, 196, 197, 198, 217, 218, 220, 246
Roether, Capt Jeff "Wedge" 101, 241
ROs (Response Options) 204
Rose, Capt David "Logger" 199, 246
Royal Air Force 89, 90
Rozental, Dedi 248
RWR (radar warning receiver)
  ALR-56A 32, 33, 34, 35, 163
  ALR-56C 163
Ryan Teledyne Firebee II reconnaissance drone 146

S

Saddam Hussein 171, 174, 189, 203, 213
Sageburner Project 9
Saleh Al-Shamrani 247
satellite, Solwind P78-1 124
Saudi Air Force, Royal (RSAF) 151–152, 153, 185, 239, 256, 257
  F-15 kills 247
  F-15 mishaps 245
  No. 2 Sqn 239
  No. 5 Sqn 151–152, 239
  No. 6 Sqn 151, 239
  No. 13 Sqn 151, 239
  No. 34 Sqn 239
  No. 42 Sqn 151, 239
Saudi Arabia
  Dhahran 171, 176, 203
  King Faisal (Tabuk) AB 102, 171, 176, 187, 198
  Prince Sultan AB 162, 173, 176, 212
Schiavi, Capt Tony "Kimo" 87, 183, 184, 184, 185–186, 195–197, 198, 246
Schlesinger, James R. 47
Schwartz, Sha'ul 248
Schwarzkopf, Gen Norman 172
Schwarzwald 100, 101
Scott, Col Robert 93
Seek Eagle Program 59
Sellers, Peter 87
Serbia 218–219
sexual connotations, words and phrases ("so-to-speak") 78–79
Shadmi, Yiftach 248
Shafir, Relik 248
Shapira, Ronen 248
Shapira, Uzi 248
Shawler, Col Wendell 37, 43
Shipp, Capt Bruce 177
Shower, Capt Mike "Dozer" 218–223, 246
Sierra Engineering 71
Sierra Hotel: Flying Air Force Fighters in the Decade After Vietnam 66
Sikorsky MH-53 65
Sikorsky UH-60 Black Hawk 209–211, 222
Simon, Sha'ul 248
Six Day War (1967) 143
Skurigin, Col Nikolai 103–104, 107
Skyburner Project 9
Slay, Gen Alton D. 108
Smith, Col J. S. 256
Snooze, Capt Montgomery 221
SOKO G-4 Super Galeb 215
SOKO/CNIAR Orao 217
Solan, Reuven 248
Solwind P78-1 satellite 124
SPAD XIII 60
specifications 258
speed brake 42–43
SPO (Systems Project Officer) 21
squadron life 84–85, 87
Star Wars 87, 162
Steele, "Man-O" 218, 221, 222, 223
Stern, Yoav 248
Stevenson, James P. 31
Straight, "Boa" 87
Strapa, LtCmdr Joe "Hoser" 69
Stroud, MajGen Ansel 131
Stuck, Don 35, 49
submarines 127–128
Sukhoi
  Su-7 "Fitter" **194**, 201
  Su-15TM "Flagon" 152
  Su-20 "Fitter" 174, 203
  Su-22 "Fitter" 147, 174, **194**, 201, 203
  Su-24MK "Fencer" 174
  Su-25 "Frogfoot" 200
  Su-27 "Flanker" **160**, 160, 163, **233**
  Su-28 "Frogfoot" 200
Sveden, Lt David G. 246
Sweeney, "K-Bob" 217
Sweeney, Jr., Gen Walter C. 9
Syrian air force 144, 146–147
Syrian army, 10th Armored Division 146, 147
Systems Project Officer (SPO) 21

T

Tactical Electronic Warfare Suite (TEWS) 25, 32–35, 169, 229
take-off 78–80

Target Recognition, Non-Cooperative (NCTR) 163, 169
Tate, Capt Steve 246
testing
  Category I (CDT&E) 37–42, 43, 48
  Category II (AFDT&E) 37, 43, 47–49, 148
  Category III (FOT&E) 37, 49, 50–51
  central computer 46
  engine 43–46
  gun 47, 48, 51
TEWS (Tactical Electronic Warfare Suite) 25, 32–35, 169, 229
TFX (Tactical Fighter Experimental) 8 12, 14, 15
Thiel, LtCol Bill 180, 181, 182–183
Thompson, "Dallas" 87
Three Little Pigs 103
throttle quadrant, MSIP 168
throttles 30
  see also Hands On Throttle And Stick
Thurman, LtGen William E. 256
Till, Capt Bruce "Roto" 184, 195, 196, 197, 198
time line 252–254, 256–257
titanium 24
Tollini, Capt Rick "Kluso" 176, 177, 178, 179, 180, 181, 181, 184, 185, 187, 192, 246
  kills 189, 189, 190–191, 191
Towering Inferno 67
Tracor ALE-40/45 Countermeasures Dispenser (CMD) 32, 32, 33, 132
Transall C 160 205
Tunis PLO HQ raid 148, 148–149
Tupolev
  Tu-16 "Badger" 8
  Tu-16 (H-6D) "Badger" 174
  Tu-22 "Blinder" 174
  Tu-22M "Backfire" 125–126
  Tu-95 "Bear" 8, 18, 134, 251
  Tu-95 "Bear-D/E" 95
  Tu-95 "Bear-F" 126–128
  Tu-95KM "Bear-C" 119
  Tu-142 "Bear-F" 126–128
Turkey, Incirlik AB 172–173, 175, 205, 206, 208, 209

U

Underhill, Craig "Mole" 87, 192, 193, 194, 195, 246
United Nations 7
  Security Council Resolution 781 215
United States Air Force
  Aerospace Defense Command (ADC) 122, 124, 126, 238
  Aerospace Expeditionary Force (AEF) 212–213, 257
  Air Defense Weapons Center (ADWC) 126
  Air Force Systems Command (AFSC) 37, 40, 252
    Aeronautical Propulsion Laboratory 15
    Aeronautical/Aerospace Systems Division 12, 14, 15, 17
  Air Training Command (ATC) 10
  Alaskan Air Command (AAC) 119
  Eagle Replacement Training Unit (RTU) 51, 56, 57, 58, 62, 84
  F-15 kills 246
  F-15 mishaps 240–243
  F-15 program as political football 42
  Fighter Group, 32nd 237
  Fighter Interceptor Group, 119th 126
  Fighter Weapons School 112
  Headquarters (Air Staff) 12, 20
  leaders 9
  Logistics Command 256
  Military Personnel Center 58
  pilot management policy 10
  Strategic Air Command 7, 9, 18–19
  Surgeon General office 57
  Tactical Air Command 9, 19, 58, 60, 102, 122
    Required Operational Capability (ROC-9-68) statement 19–20
  Tactical Air Forces (TAF) 19, 20
United States Air Force bases (AFB unless stated)
  see also Italy, Aviano AB; Saudi Arabia; Turkey, Incirlik AB
  Bitburg (AB), Germany 84, 86, 93, 96, 102, 111, 206, 207, 237, 254
    Roether Memorial Zulu Alert Facility 94, 96, 98
      see also "Zulu Alert"
  Castle, California 125
  Edwards, California 37, 39, 39, 48, 49, 49, 70, 238, 253, 257, 262
    Air Force Flight Test Center 256
  Eglin, Florida 51, 108, 109, 149, 206, 231, 235, 237, 238, 256
  Elmendorf, Alaska 104, 119, 121, 122, 125, 206, 229, 237
  Holloman, New Mexico 102, 237
  Kadena (AB), Japan 97, 111, 114, 138, 156, 237, 254
  Keflavik (NAS), Iceland 127, 128, 129, 238
  Lakenheath (RAF), England 203, 208, 226, 237, 247
  Langley, Virginia 56, 59, 60–61, 65, 93, 95, 102, 103, 122, 237, 238, 253
  Luke, Arizona 37, 51, 53, 53, 56, 56, 57, 58, 65, 80, 102, 126, 144, 238
  MacDill, Florida 61–62
  McChord, Washington 124, 125, 238
  Minot, North Dakota 125, 238
  Mountain Home, Idaho 235, 238
  Nellis, Nevada 51, 65–66, 79, 102, 135, 238
  Selfridge, Michigan 60
  Soesterberg (AB), Netherlands 103, 207, 237
  Spangdahlem (AB), Germany 102, 206–207, 207, 238
  Tonopah, Nevada 91
  Tyndall, Florida 121, 126, 134, 206, 238
  Warner-Robins, Air Logistics Center 109, 110, 162, 238, 256, 257
United States Air Force squadrons
  1st FS "Fightin' Furies/Griffins" 121, 126, 238
  2nd TFTS "Unicorns" 126, 238
  4th TFS 108
  5th FIS "Spittin' Kittens" 125, 126, 238
  7th TFS "Bunyaps" 102, 237
  8th TFS "Black Sheep" 74, 102, 106, 238
  9th TFS "Iron Knights" 102, 238
  12th FS "Dirty Dozen" (formerly 54th FS) 55, 114, 119–120, 121, 122, 206, 235, 237, 251
  16th TFS 108
  19th FS "Gamecocks" (formerly 43rd TFS) 119, 121, 122, 235, 237
  22nd FS "Stingers" 94, 206, 237
  25th TFS 108
  27th TFS "Fighting Eagles" 59, 60, 62–63, 66, 94, 171, 237
  32nd FS "Wolfhounds" 23, 73, 93, 101, 103, 105–107, 107, 117, 172–173, 205, 205, 206, 207, 237, 250
  33rd TFS "Gorillas" (later 58th TFS) 102
  40th FLTS "Fightin' Red Devils" 108, 237
  40th TFS 108
  43rd TFS "Polar Bears" (later 19th FS) 119, 119, 120, 237
  44th TFS "Vampires" 114, 237
  48th FIS 122–124, 123, 126, 238
  53rd TFS "Tigers" 73, 94, 95, 100–101, 110, 206, 207, 207, 208, 209, 215, 221, 237, 238
    Operation *Desert Storm* 172, 176, 176, 199–201, 208, 209–211
  54th TFS "Leopards" (later 12th FS) 119, 206, 237
  55th TFTS 253

- 57th FIS "Black Knights" 127, 128–129, 238
- 57th FS "Fighting Cocks" 237
- 58th TFS "Gorillas" 102, 108, **109**, 111, 112, 165, 171, 171–172, 237
  - Operation *Desert Storm* 175, 176–183, 184–187, 179, 189–198, 199
  - CITGO flight 176, 178, 180–183, 187, 189–192, 195–198
  - PENNZOIL flight 176–180, 181, 184, 185
  - ZEREX flight 184–187
- 59th TFS "Golden Pride/Proud Lions" 108, 111, 165, 206, 208, 237
- 60th TFS "Fighting Crows" 108, 111, 165, 237
- 64th Aggressor Squadron 239
- 65th Aggressor Squadron 235
- 67th TFS "Fighting Cocks" 111, 114, **115**, **208**
- 71st TFS "Ironmen/Mailed Fist" 59, 60, **61**, 62, 63, 89, 94, 103, 171, 173, 237, **254**
  - UNION flight 184
- 85th TES "Skulls" 64, 238
- 90th FS "Pair o' Dice" 120
- 94th TFS "Hat in the Ring" 59, 60, 63, 67, 68, 102, 117, 203, 237
- 95th FS "Mr Bones/Boneheads" 125, 126, 238
- 110th FS 237
- 128th BS 132
- 318th FS "Green Dragons" 125, 126, 238
- 390th FS "Wild Boars" 235, 238, 252
- 422nd FWS 37, 51, 69, 70
- 422nd Test & Evaluation Squadron "Green Bats" 156, 176, 238
- 426th TFTS "Killer Claws" 73, 238
- 433rd FWS "Satan's Angels" 63, 66, 238
- 445th FLTS "Fightin' Red Devils" 238
- 461st TFTS "Deadly Jesters" 65, 73, 102, 238
- 493rd FS "Grim Reapers" 116, 167, 203, 207–208, 212, 215, **217**, **226**, 227, 237
  - DIRK flight 223–224
  - EDGE flight 218–223
  - KNIFE flight 217–218
- 517th AS 120
- 525th TFS "Bulldogs" **94**, 94, 95, 100, 172–173, 206, 237
- 550th TFTS "Silver Eagles" 73, 238
- 555th TFTS "Triple Nickel" 11, 53, 54, 56, 56, 57, 58–59, 66, 73, 238
- 962nd AW&CS 120
- 2875th FLTS 238
- 3247th Test Squadron 41
- 4477th TES "Red Eagles" 91
- 6512th Test Squadron 41, 124
- life in 84–85, 87

United States Air Force wings
  - 1st TFW **59**, 59–63, 65–66, 93, 102, 108, 119, 171, 235, 237, 253
  - 1st TFW (P) (Provisional) 171, 173, 176
  - 3rd Wing 119, 120, 122, 229, 230, 237
  - 15th TFW 60
  - 18th Wing 97, 101, 111, 112, 114, 114, 117, 138, 206, 208, 237
  - 33rd FW "Nomads" 64, 73, 107–108, **109**, 111, 132, 169, **171**, **179**, 184, **185**, **231**, 235, 237, 257, 256
  - 36th TFW 84, 93–97, 99–101, 102, 117, 132, 172, **197**, 206, 207, 237, **254**
  - 46th Test Wing 237
  - 48th FW **226**, 237
  - 49th TFW 102–103, 108, 237
  - 52nd FW 207, 208, 238
  - 53rd Wing 238
  - 56th TFW 62
  - 57th FWW 65–66, 102, 238
  - 58th TTW 51, 102, 126, 238
  - 86th TFW 103
  - 325th TTW 126, 132
  - 325th FW 238
  - 366th Wing 238
  - 405th TTW **73**, 126, 132, 238
  - 412th Test Wing 238
  - 432nd TRW 53
  - 552nd Airborne Warning and Control Wing 128
  - 6510th Test Wing 37
- United States Air Forces Europe (USAFE) 93, 96, 103, 172, 175, 206, 207
- United States Air National Guard 131, 213, 238
  - bases (ANGB unless stated)
    - Dobbins, Georgia 132, 238
    - Hickam, Hawaii 238
    - Homestead (ARB), Florida 134
    - Jacksonville, Florida 238
    - Key West (NAS), Florida 134
    - Klamath Falls, Oregon 134, 238
    - Lambert Field, Missouri 135, **137**, 137, 238
    - Loring, Maine 134
    - New Orleans (NAS), Georgia 131, 238
    - Otis, Massachusetts 108, 134, 141, 238
    - Portland, Oregon 238
  - Florida, 125th FW 134, **139**, 235, 238
    - 158th FS **140**, 141
    - 159th FS 134, 137, 238
  - "full time Guardsmen's" duties 132–134
  - Georgia, 116th FG/TFW 132, 238
    - 128th TFS 131, 132, 238
  - Hawaii, 154th Wing "HANGmen" **127**, **131**, 238
    - 199th TFS 132–134, 138, 141, 238
  - Louisiana, 159th FW "Coonass/Bayou Militia" **161**, 238
    - 122nd TFS 131, **133**, 141, 238
  - Massachusetts, 102nd FW 141, 238
    - 101st FS 126, 134, **138**, 139–140, 141, 207, 238
  - Missouri, 131st FW (MOGAR) 238
    - 110th FS 126, **132**, 135, **137**, 137–138, 141, **213**, 213, 238
  - Oregon, 142nd FW 238
    - 123rd FS "Red Hawks" 126, 134, 139, 141, 238
  - Oregon, 173rd FW 238
    - 114th FS 134, 141, 238
- United States Army Air Force
  - 1st Fighter Group 60
  - 18th FG 112
  - 33rd FG 107–108
  - 36th FG 93
  - 49th Pursuit/Fighter Group 102
  - 325th TTW 126
  - 493rd FBS 207
- United States Army Air Service, 1st Pursuit Group 59–60
- United States Department of Defense 8, 31, 32, 42, 43, 44
- United States Navy 8, 28–29, 31, 253
  - VFX competition 21
  - VX-4 69
- UPT (Undergraduate Pilot Training) 58
- USSR (Union of Soviet Socialist Republics) 7

V

- variants 249–251, **259**, 261–262
- vectoring thrust in forward flight (VIFF) maneuver 89–90
- vertical situation display (VSD) 24, 27, 28
- VFX competition 21
- Vietnam, North, air superiority over 10–11
- Vietnam (North) People's Air Force (VPAF) 10
- Vietnam War (1954–75) 9–11, **16**, 17, 19, 20, 28–29, 53, 56, 60
- VIFFing (vectoring thrust in forward flight maneuver) 89–90
- visual identification (VID) 69, 70–71
  - "Eagle Eye" device 70
- Visual Identification Target Acquisition System (VITAS) 71
- Vmax switch 80
- Vought A-7 Corsair II 11, 28
- VSD (vertical situation display) 24, 27, 28

W

Walker, Larry 27–28
War of Attrition (1967–70) 143
Watrous, Capt Donald "Muddy" 87, 172, 246
weapons 35
  bombs
    GBU-15 2,000lb glide 145, 148
    GBU-39 250lb SDB GPS-guided 230
    Mk 82 500lb LDGP 148, 149
    Mk 84 LDGP 145
    Spice GPS 150
  cannon
    GAU-7A 25mm 47, **48**
    GSh-301 30mm 175
    M61A1 Vulcan 20mm 42, 47, 48, 51, 74, 82, 140, 144, 230–231
  Israeli, new 150
  JDAM 231, 234
  missiles
    AGM-45 Shrike 146
    AGM-65 Maverick TV-guided 146
    AGM-78 Standard 146
    AIM-4D 12
    AIM-7 Sparrow SARH 8, 10, 17, 44, 55, 59, 69, 106
    AIM-7E 16
    AIM-7E-2 10, 54
    AIM-7F **23**, 48, 51, 54–55, **85**, 144, 145, 145, 147, 148, 226
    AIM-7L 25
    AIM-7M 173, 179, 182, 183, 186, 190, 191, 193, 196, **197**, 197, 198, **213**, 219, 220, 226
    AIM-9 Sidewinder heat-seeking 8, 51, **55**, **59**, 74, **87**, **106**, 140–141, **217**
    AIM-9B 29, 82
    AIM-9D 82
    AIM-9E 48, 82
    AIM-9G 82
    AIM-9J 25, 82, 226
    AIM-9L **23**, 55, 82–83, 84, **85**, 90, **173**, 226, 253
    AIM-9L, accidental firing 100–101
    AIM-9M **67**, **68**, **85**, 190, 191, **197**, 198, 199, 200, 201, 219, 226
    AIM-9P 25, 82, 226
    AIM-9X **104**, 229, **233**
    AIM-54 Phoenix 88
    AIM-82A 82, 253
    AIM-120 AMRAAM **68**, **89**, **104**, **114**, 149, 162, 169, 210, **213**, **215**, **217**, 218, 219, 220, 222, **224**, 224, 226–227
    AIM-120A **148**, 159-160
    AIM-120B **145**
    AS-4 "Kitchen" nuclear-tipped air-launched cruise 125-126
    Ault report on firing 28-29
    Boeing CQM-99B BOMARC surface-to-air **50**, 51
    Iraqi SAM 211-212
    Keres surface-to-air anti-radiation 146
    Matra 550 Magic 88, 89
    Matra R530 radar 88
    R-60/AA-8 "Aphid" IR 175
    Rafael AGM-142 Popeye stand-off air-to-ground 149
    Rafael Python 3 advanced IR 143, 144, 145, 147
    Rafael Python 4 IR 148, 149
    Shafrir 2 IR 143
    Sparrow 29
    Syrian surface-to-air (SAM) 146-147
    Vought ASM-135A anti-satellite 124, 125
    Ze'ev surface-to-surface 146
weapons engagement zone (WEZ) 25, 84
weapons instructor courses (WICs) 66
Weapons Officers 79
weight-on-wheels (WoW) override 150-151
Welch, BrigGen Larry D. 61
Westinghouse 17
White Sands Army Missile Range, New Mexico 51
Williams, Mark "Willie" 177, 178, 179, 180, 189, 190, 191
wing design 23
wings, variable-geometry (VG) 14, 17, 18
wingtips, raked 42

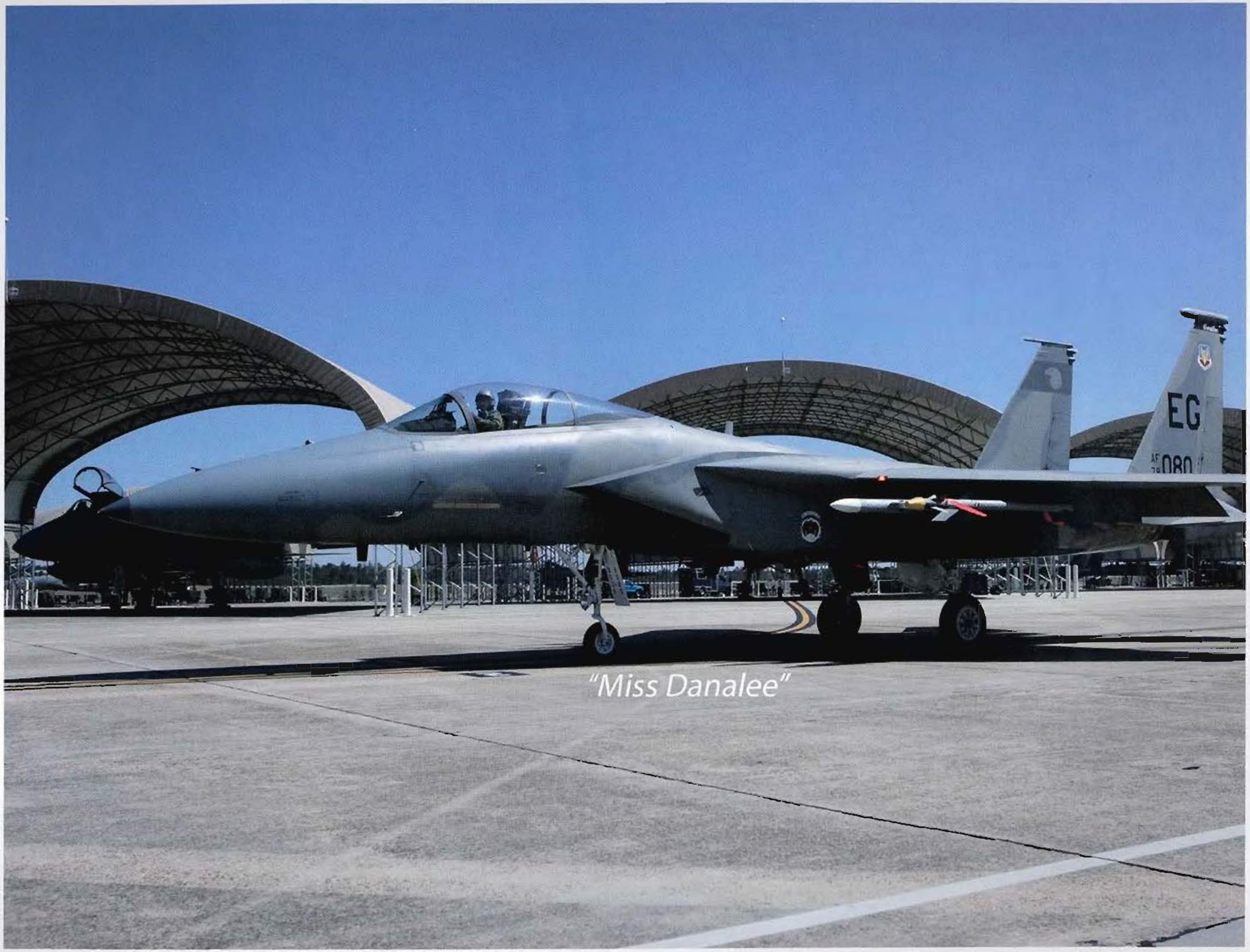
Y

Yakovlev Yak-36 90
Yates, Col Ronald W. 256
Yom Kippur War (1973) 143
Yugoslavia, Federal Republic of 215, 217
  air force (FRYAF) 217

Z

Zinker, LtCol Benyamin "Benny" 144, 145, 248
Zuckert, Eugene M. 12
"Zulu Alert" (QRA(I)) 94, 96-101, 104
  4th July Alpha scramble 103-107
  sitting hot alert 98-99

LN
493 FS
LN
AF
86 0178
LN
AF
84 010



“Miss Danalee”